GE
Intelligent Platforms

Programmable Control Products

VersaPoint* I/O System

Positioning Modules

User's Manual GFK-2125

March 2010

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Chapter 1

VersaPoint Positioning Modules

This manual contains the instructions and reference information needed to install and use VersaPoint positioning modules:

- Absolute Encoder Module (IC220MDD841)
- Incremental Encoder Module (IC220MDD842)

Chapter 1: VersaPoint Positioning Modules, describes the Absolute Encoder module and the Incremental Encoder module, and lists their technical specifications.

Chapter 2: Installing VersaPoint Positioning Modules, describes specific installation steps for the VersaPoint positioning modules.

Chapter 3: Module Input and Output Data, describes how a system host sends commands to a positioning module in a VersaPoint I/O Station, and then receives input data from the module.

Chapter 4: Configuration Commands, describes the commands that are used to configure VersaPoint positioning modules. In addition, chapter 5 describes each command's read version, which can be used to read the configuration parameters from the module.

Chapter 5: Commands for Defining Parameter Records, describes the output commands that can be used to define and read the parameters of two traverse paths.

Chapter 6: Positioning Commands, describes three pairs of commands that can be used to control positioning, and to read position, status, or reference mark information from the module. This chapter also gives examples of using commands for looping, backlash compensation, position detection, and homing.

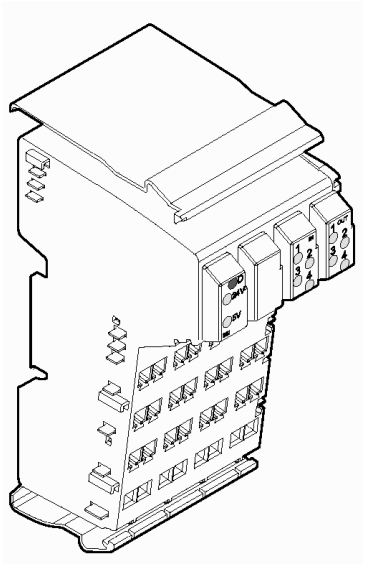
Additional Documentation

For additional installation instructions and communications information, you will also need the *Network Interface User's Manual* for your system.

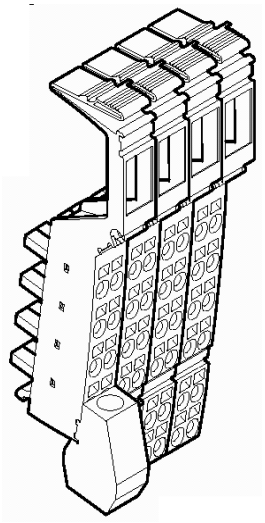
Module Descriptions

The VersaPoint positioning modules, IC220MDD841 and IC220MDD842, are designed for the connection of an encoder. They are suitable for all standard signals. Both modules supply the encoder with 5VDC and 24VDC.

A four-connector set, IC220TBK202, is used with both modules. The connectors in this set provide the field wiring terminals for the module's input and output points.



Module IC220MDD841 / 842



Connector Set IC220TBK202

Overview of Module Operation

VersaPoint positioning modules control the positioning of AC and DC drives. They can be used with both rotary and linear axes. They can also be used to simply determine the position of a drive.

Typical Applications

- Compound table positioning
- Position monitoring at valves
- Control of transport vehicles
- Adjustment of lifting platforms

Encoders

Position is detected by incremental encoders for the IC220MDD842 module, and by absolute encoders for the IC220MDD841 module. Both symmetric and asymmetric encoders can be used.

Power for the encoder is taken from the module. A short-circuit-protected power supply provides +5VDC or +24VDC for the rotary transducer supply. This enables both the initiator voltage and the output voltage to be monitored.

Module Inputs and Outputs

VersaPoint positioning modules have three digital inputs of 24VDC, four digital outputs of 24VDC, 500mA, and a connection for an optional Operator Hand Panel. Suitable input devices include limit switches and home position switches.

The three digital inputs can be configured according to the application (for example, for signaling a limit or reference point).

The four digital outputs can directly affect the process. Once a position has been specified, the module outputs can control the traversing rate and traversing direction of the drive. Switching and signaling areas are used to monitor the approach to the position.

Positioning occurs at two or three speeds, depending on the output parameters.

- For positioning with two speeds, creeping motion and rapid motion are used.
- For positioning with three speeds, fast motion is available in addition to creeping motion and rapid motion.

Commands from the Host System

The system host configures and controls a positioning module by issuing commands to the Network Interface Unit module in the I/O Station where the positioning module is located. The Network Interface Unit passes these commands to the module in the form of two words of output data. The module interprets the output data and operates accordingly.

The system host must first send commands to configure the encoder and to configure the assignment of the module's inputs and outputs. The host can then define the following parameters for two different traverse paths:

- Target position
- Target range
- Shutdown range
- Pre-shutdown range
- Rapid shutdown range
- Rapid start range
- Start range
- Friction correction value

After being configured and parameterized, VersaPoint positioning modules can operate independently of the bus and control system. The host can also use positioning commands to directly control the module during system operation.

The module monitors the positioning and sends a status message to the control system. When an error occurs, the drive is stopped immediately.

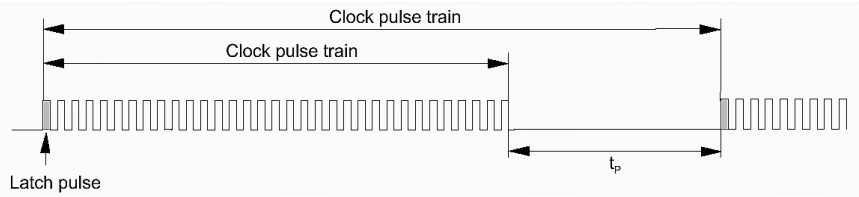
A complete set of read-only commands allows the host to read positioning, setup, and operating information from the module.

Subsequent chapters of this manual describe the configuration commands, commands for defining traverse paths, and control commands. To the host, all that is involved is placing the appropriate values into two words of output data for the module. The host then sends that data to the Network Interface Unit module using the appropriate fieldbus protocol.

Absolute Encoder Module: Actual Value Formation

The Absolute Encoder Module forms the actual value based on the counting direction from the data flow, the logic offset, and the increment evaluation.

The Absolute Encoder module generates the pulse train shown below.

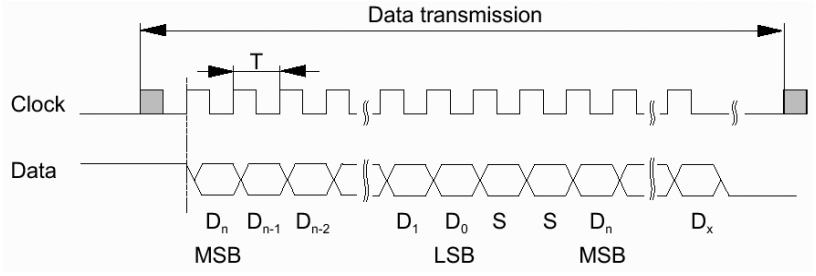


Latch pulse	Start signal for data transmission	
t_P	Pause between two clock pulse trains	t_P > 100µs

Data is transmitted on every 33 pulses by a clock pulse train. The first pulse latches the position of the absolute encoder. The position is transmitted from the encoder to the Absolute Encoder Module with the following 32 pulses. Between the clock pulse trains, there is a pause t_P of at least 100µs.

On the first pulse of a clock pulse train, the encoder accepts the current position in its memory. On the next falling edge of the clock signal, the most significant bit (Dn, MSB) is read, as shown below. With each further subsequent falling edge, the next bit is read. If the least significant bit (D0, LSB) is read, up to two other bits (special bits e.g., parity) are read for encoders with a corresponding function.

If signals are still present at the clock input after transmission of bit D0 or the special bits, data transmission is repeated, beginning with the MSB (Dn). DX indicates the last transmitted bit.



S	Special bit
T	Duration of a clock signal T = 2.5 µs

How to Configure Data Evaluation

The *Configure Encoder* command (see chapter 4) must be used to set up the encoder so that the module can evaluate the data correctly.

When data transmission is completed, the corresponding number of data bits is evaluated (masked out) according to the configuration of the "Resolution" parameter.

The module converts the data flow into an absolute position value according to the code (Gray code or binary code).

The current actual position can be requested using the *Read Position* command as described in chapter 6.

Actual Value Range

The defined actual value range is the value range from -2^{25} to $2^{25}-1$.

On leaving the defined actual value range, the counter accesses the overflow range. Pulse detection continues, but an error is indicated in the status word (see *Read Status* command in chapter 6).

If a rotary axis has been configured, the actual position value is always mapped in the specified positioning range, which is determined for the Absolute Encoder Module by the resolution of the encoder.

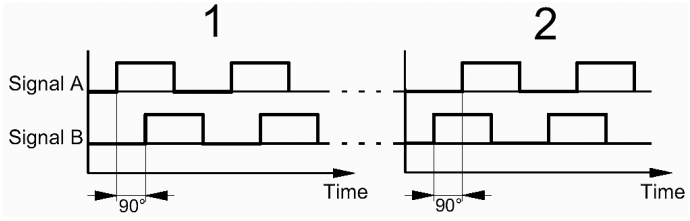
Incremental Encoder Module: Actual Value Formation

The Incremental Encoder Module (IC220MDD842) forms the actual value based on the counting direction from the count value of the recorded pulses and the reference point.

Count Direction

The process of phase-shifting the encoder pulse trains is used to determine the counting direction, and therefore the sign bit for the actual value:

- If signal A is ahead, the count is upwards (positive) (signal curve1)
- If signal B is ahead, the count is downwards (negative) (signal curve2).



The counting direction can be reversed for symmetrical encoders by exchanging the wire pairs. A $\bar{A}$ and B $\bar{B}$. For asymmetrical encoders, A* can be swapped with B*.

Instead of swapping wires, the VersaPoint Incremental Encoder module can be configured for direction reversal using the *Configure Encoder* command.

Actual Value Range

The defined actual value range is -2^{25} to $2^{25}-1$.

On leaving the defined actual value range, the counter accesses the overflow range. Pulse detection continues, but an error is generated.

For a configured rotary axis, the actual position value is always mapped in the specified positioning range, which is determined for the Incremental Encoder Module by the modulo value.

Reference Point

The Incremental Encoder Module calculates the current position of the drive based on the increment evaluation and the reference point using this formula:

$$P = Z \times \frac{A}{B} + RP$$

P	Current position
Z	Internal counter status
A	Numerator of the Increment evaluation
B	Denominator of the Increment evaluation
RP	Reference point

Reading the Current Position

The current position can be determined using the *Read Position* command as described in chapter 6.

Setting the Reference Point

When the reference point is set using a Control Positioning command, as described in chapter 6, the internal counter status is set to 0 so that the reference point is indicated as the current position.

Module Specifications, IC220MDD841 and IC220MDD842

These module specifications apply to both VersaPoint positioning modules. Additional specifications for each module are listed on subsequent pages.

Programming Data	
ID code	BF hex (191 decimal)
Length code	02 hex
Input data length	4 bytes
Output data length	4 bytes
Parameter channel (PCP)	0 bytes

Ambient Conditions		
Regulations	Developed according to VDE 0160, UL 508	
Humidity	75% on average; 85% occasionally; (no condensation)	
Degree of protection according to DIN 40050, IEC 60529	IP 20	
Degree of protection according to DIN 57106-1	Class 3	
Overvoltage class	II (low-level signal)	
	III (power level)	
Gases that may endanger functions (according to DIN 40046-36, DIN 40046-37)		
Sulfur dioxide (SO_2)	Concentration 10 ± 0.3 ppm	
	Ambient conditions	
	- Temperature:	25°C (77°F) (± 2°C)
	- Humidity	75% (± 5%)
Hydrogen sulfide (H_2S)	Concentration 1 ± 0.3 ppm	
	Ambient conditions	
	- Temperature:	25°C (77°F) (± 2°C)
	- Humidity	75% (± 5%)

Mechanical Demands	
Vibration test sinusoidal vibrations according to IEC 60068-2-6; EN 60068-2-6	2g load (low-level signal)
Shock test according to IEC 60068-2-27; EN 60068-2-27	25g load for 11ms, half sinusoidal wave, three shocks in each space direction and orientation

Conformance With EMC Directive 89/336/EEC		
Noise Immunity Test According to EN 50082-2		
Electrostatic discharge (ESD)	EN 61000-4-2/ IEC 61000-4-2	Criterion B 6kV contact discharge 6kV air discharge (without labeling field) 8kV air discharge (with labeling field in place)
Electromagnetic fields	EN 61000-4-3	Criterion A
	IEC 61000-4-3	Field strength: 10V/m
Fast transients (burst)	EN 61000-4-4/	Criterion B
	IEC 61000-4-4	Supply lines: 2kV I/O cables: 2kV Criterion A All interfaces: 1kV
Conducted interference	EN 61000-4-6	Criterion A
	IEC 61000-4-6	Test voltage 10 V
Noise Emission Test According to EN 50081-2		
Noise emission of housing	EN 55011	Class A

General Data	
Housing dimensions (width x height x depth)	48.8mm x 120mm x 71.5mm (1.921in x 4.724in x 2.815in)
Operating mode	Process data operation with 2 words
Connection method of the sensors	2-wire and 3-wire technology
Connection method of the actuators	2-wire and 3-wire technology
Connection method for all cables	Spring-clamp terminals
Conductor cross section (typical)	0.2mm² through 1.5mm² (24 to 16 AWG)

Supply of the Module Electronics and the I/O Through the Bus Module/Power Module (U_M, U_S, U_L)		
Connection method		Through potential routing

Encoder Supplies	
5V Encoder Supply	
Voltage range	4.75V to 5.25V
Short-circuit protection	Electronic and thermal
Current carrying capacity	500mA
24V Encoder Supply	
Voltage range	19.2V to 30.0V
Short-circuit protection	Electronic and thermal
Current carrying capacity	500mA
The state of the encoder supplies (5V/24V) is displayed via two LEDs. If the internal voltage for the encoder electronics fails, an I/O error is generated. The DIAG LED flashes at 2 Hz to indicate the error.	

Discrete Inputs		
Number	4	
Input design	According to EN 661131-2 Type 1	
Switching thresholds:	Low signal range: -30VDC to +5VDC High signal range: +13VDC to +30VDC	
Common potentials	Main supply, ground	
Nominal input voltage	24VDC	
Permissible range	-30V < U_{IN} <+30VDC	
Nominal input current	5mA typical	
Connection method	2-wire and 3-wire technology	
Delay time	< 1 millisecond	
Permissible cable length to the sensor	<30 m (98.43 ft)	
Use of AC sensors	AC sensors in the voltage range <U_{IN} are limited in application. The signal levels of the AC sensors must correspond with EN 61131-2, Type1)	
Characteristic curve of the current	Linear in the range 1V > U_{IN} < 30V	
	Input Voltage	*Typical Input Current*
	-30<U_{IN}<0.7	0
	3	0.4
	6	1.0
	9	1.7
	12	2.3
	15	3.0
	18	3.7
	21	4.4
	24	5.0
	27	5.7
	30	6.4

Digital Outputs	
Number	4
Connection method	2-wire and 3-wire technology
Nominal output voltage U_{OUT}	24VDC
Differential voltage for I_{nom}	$\leq$ 1 V
Nominal current per output I_{nom}	0.5A
Tolerance of the nominal current	+10%
Total current of the outputs	2A
Protection	Short-circuit; overload (thermal)
Nominal load	Ohmic: 48 Ohms / 12W
	Lamp: 12W
	Inductive: 12VA (1.2H, 50Ω)
Signal delay upon power up;	Ohmic nominal load: 100 µs, typical
	Lamp nominal load: 100ms, typical (with switching frequencies up to 8Hz; above this frequency the lamp load responds like an ohmic load)
	Inductive nominal load : 100ms, typical (1.2H, 50Ω)
Signal delay upon power down;	Ohmic nominal load: 1ms, typical
	Lamp nominal load: 1ms, typical
	Inductive nominal load: 50ms, typical (1.2H, 50Ω)
Switching frequency: For Ohmic and Lamp loads. switching frequency is limited by the data rate, the number of bus devices, the bus structure, the software and the control system used.	Ohmic nominal load: 300Hz, maximum
	Lamp nominal load: 300Hz, maximum
	Inductive nominal load: 0.5Hz, maximum at 500mA (0.5H, 48Ω)
Overload response	Auto restart
Response after inductive overload	Output may be damaged
Response time after short-circuit	Approximately 400ms
Reverse voltage endurance against short pulses	Yes
Strength against polarity reversal of the supply voltage	Components on the NIU or power module
Strength against permanently applied surge voltage	No
Validity of output data after connection of 24V voltage supply (power up)	5ms, typical
Response upon power down	The output follows the supply voltage without delay.
Single maximum energy in free running	400 mJ, maximum
Protective circuit type	Integrated 38.6V Zener diode in output
Overcurrent shutdown	At 0.7A, minimum
Output current when switched off	100µA, maximum
Output voltage when switched off	1V, maximum

Output Characteristic when Switched On (typical)	
Output Current (A)	*Differential output voltage (V)*
0	0
0.1	0.04
0.2	0.08
0.3	0.12
0.4	0.16
0.5	0.20

Concurrent Channel Derating
None

Safety Devices	
Surge voltage	Safety elements of the bus module or power module
Polarity reversal of voltage supply	Safety elements of the bus module or power module It is necessary to protect the voltage supply. The power supply unit should be able to supply 4 times (400%) the nominal current of the external fuse.
Short-circuit protection for the outputs (segment circuit)	Short-circuit-proof (automatic restart)

Error Messages to the Higher-Level Control or Computer System	
Short-circuit/overload of an output	Yes, an error message is generated when an output is shorted and switched on. The diagnostic LED (D) flashes on the module at 2Hz (medium) under these conditions.
Short-circuit/overload of the encoder supply	Yes, an error message is generated when the encoder supply is shorted or overloaded. The diagnostic LED (D) flashes on the module at 2 Hz (medium) under these conditions.
Failure of the main or segment voltage(U_M / U_S)	Yes
Failure of the internal voltage for the encoder electronics	Yes, I/O error to controller board; The diagnostic LED (D) flashes on the module at 2Hz (medium) under these conditions.

Electrical Isolation/Isolation of the Voltage Areas	
To provide electrical isolation between the logic level and the I/O area it is necessary to supply the NIU and the encoder module via the NIU or a power module from separate power supply units. Interconnection of the 24V power supplies is not allowed.	
Common Potentials	
24V main power, 24V segment voltage and GND have the same potential. FE (functional earth ground) is a separate potential area.	
Separate Potentials in the System Comprising NIU/Power Module and Encoder Module	
- Test distance	***- Test voltage***
5V supply incoming remote bus/7.5V supply (bus logic)	500VAC, 50 Hz, 1 min
5V supply outgoing remote bus/7.5V supply (bus logic)	500VAC, 50 Hz, 1 min
7.5V supply (bus logic)/24V supply (I/O)	500VAC, 50 Hz, 1 min
7.5V supply (bus logic)/functional earth ground of the encoder supply	500VAC, 50 Hz, 1 min
24V supply (I/O)/functional earth ground	500VAC, 50 Hz, 1 min
24V supply (I/O)/functional earth ground of the encoder supply	500VAC, 50 Hz, 1 min
Functional earth ground of the encoder supply/functional earth ground	500VAC, 50 Hz, 1 min

Specifications for Absolute Encoder Module IC220MDD841

General Data	
Weight	130 g (without connector)
Ambient temperature (operation)	-25°C to +55°C (-13°F to +131°F)
Ambient temperature (storage/transport)	-25°C to +85°C (-13°F to +185°F)

Power Consumption	
Communications power	7.5V
Current consumption from the local bus	60mA, maximum
Power consumption from the local bus	0.45W, maximum
Segment supply voltage U_S	24VDC (nominal)
Nominal current consumption at U_S	2A, maximum
Segment supply voltage U_M	24VDC (nominal)
Nominal current consumption at U_M	1A, maximum

Absolute Encoder Inputs	
Number	1
Encoder signals	Clock, clock inverted, data, data inverted
Signal connection method	Shielded cables; Unshielded cables may lead to erroneous results in environments prone to interference.

Encoder Specifications	
Types	Single-turn or multi-turn
Resolution	8 bits to 26 bits (can be parameterized)
Code type	Gray code, binary code
Parity monitoring	None, even, odd
Reversal of direction of rotation	Yes
Encoder supply	5V (500mA) or 24V (500mA)
Transmission frequency	400 kHz
Cable length	Less than 30m (98.425ft.) for shielded cable

Power Dissipation for Module IC220MDD841	
Formula to calculate the power dissipation of the electronics $P_{EL} = P_{LO} + P_{ES} + P_{DI} + P_{DO}$ $P_{EL} = 0.450\ W + 0.440\ W + \sum_{m=1}^{4} (U_{INm} \times \frac{U_{INm} - 2.5\ V}{4400\ \Omega}) + \sum_{n=1}^{4} (0.071\ W + I_{Ln}^2 \times 0.4$	
Where	
P_{EL}	Total power dissipation of the module
P_{LO}	Power dissipation of the logic
P_{ES}	Power dissipation of the encoder supply
P_{DI}	Power dissipation of the digital inputs
P_{DO}	Power dissipation of the digital outputs
m	Index of the number of set inputs m = 1 to 4
n	Index of the number of set outputs n = 1 to 4
U_{INm}	Input current of the input m
I_{Ln}	Load current of output n
Example calculation for the power dissipation of the module at maximum load:	
U_{IN} = 30V for all inputs; I_L = 0.5A for all outputs; 4 inputs; 4 outputs	
$P_{EL} = P_{LO} + P_{ES} + P_{DI} + P_{DO}$	
P_{EL} = 0.450W+ 0.440W+ 4 x (30V x 27.5V / 440Ω) + 4 x (0.071 W+ 0.25 A^2 x 0.4Ω	
P_{EL} = 0.450W+ 0.440W+ 0.75W+ 0.684W	
P_{EL} = 2.324W	
Power dissipation of the housing P_{HOU}	2.7W (within the permissible operating temperature)

Specifications for Incremental Encoder Module IC220MDD842

General Data	
Weight	130 g (without connector)
Ambient temperature (operation)	0 °C to +55°C (32°F to +131°F)
Ambient temperature (storage/transport)	-25°C to +85°C (-13°F to +185°F)

Power Consumption	
Communications power	7.5V
Current consumption from the local bus	110mA, maximum
Power consumption from the local bus	0.825W, maximum
Segment supply voltage U_S	24VDC (nominal value)
Nominal current consumption at U_S	2A, maximum
Segment supply voltage U_M	24VDC (nominal value)
Nominal current consumption at U_M	1A, maximum

Incremental Encoder Inputs	
Number	1
Encoder signals	Two pulse trains, electrically shifted 90° (A and B) and one reference signal (Z)
Signal connection method	Shielded cables; Unshielded cables may lead to erroneous results in environments prone to interference.

Encoder Specifications	
Symmetrical Pulse Encoder	Symmetrical pulse train (RS-422) , transversal track
Encoder supply	5V
Inputs	A and $\bar{A}$, B and $\overline{B}$, Z and $\overline{Z}$
Input frequencies	Up to 500 kHz
Cable length	30 m (98.425 ft.) for shielded cable
Asymmetrical Pulse Encoder	Asymmetrical pulse train without transversal track
Encoder supply	5V or 24V
Inputs	A*, B*, Z*
Input frequencies	Up to 50 kHz
Cable length	25m (82.021ft.), maximum for 5V supply and shielded cable <30m (98.425ft.) for 24V supply and shielded cable

Power Dissipation for Module IC220MDD842	
Formula to calculate the power dissipation of the electronics $P_{EL} = P_{LO} + P_{ES} + P_{DI} + P_{DO}$ $P_{EL} = 0.825\ W + 0.440\ W + \sum_{m=1}^{4} (U_{INm} \times \frac{U_{INm} - 2.5\ V}{4400\ \Omega}) + \sum_{n=1}^{4} (0.071\ W + I_{Ln}^2 \times 0.4\ \Omega)$ Where P_{EL} Total power dissipation of the module P_{LO} Power dissipation of the logic P_{ES} Power dissipation of the encoder supply P_{DI} Power dissipation of the digital inputs P_{DO} Power dissipation of the digital outputs m Index of the number of set inputs m = 1 to 4 n Index of the number of set outputs n = 1 to 4 U_{INm} Input current of the input m I_{In} Load current of output n Example calculation for the power dissipation of the module at maximum load: U_{IN} = 30V for all inputs; I_L = 0.5A for all outputs; 4 inputs; 4 outputs $P_{EL} = P_{LO} + P_{ES} + P_{DI} + P_{DO}$ $P_{EL} = 0.825W + 0.440W + 4 \times (30V \times 27.5V / 4400\Omega) + 4 \times (0.071W + 0.25\ A^2 \times 0.4\ \Omega)$ $P_{EL} = 0.825W + 0.440W + 0.75\ W + 0.684W$ $P_{EL} = 2.699W$	
Power dissipation of the housing P_{HOU}	2.7W (within the permissible operating temperature)

Chapter 2 Installation

This chapter provides specific installation information for the VersaPoint positioning modules, including:

- Module Dimensions
- Terminal Assignments
- Connections for Encoders, Sensors, and Actuators
  - Encoder Connections
  - Sensor Connections
  - Actuator Connections
  - Example Connections
- Module LEDs
- Internal Circuit Diagrams

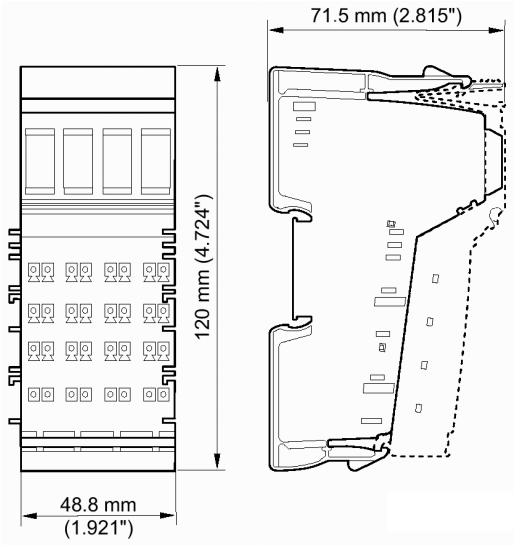
To complete the installation, you will also need to refer to the general system installation instructions in the *Network Interface Unit User Manual* for your system.

Parameterizing the Module

After installation, the module is in its initial state. In order to work with the module, it must be parameterized. The commands used to parameterize the module are described in chapters 5 and 6.

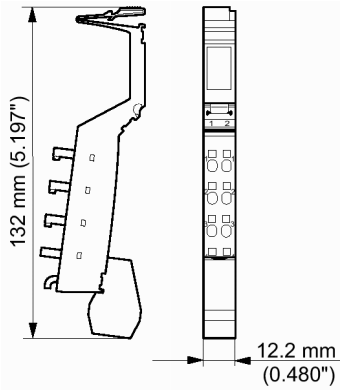
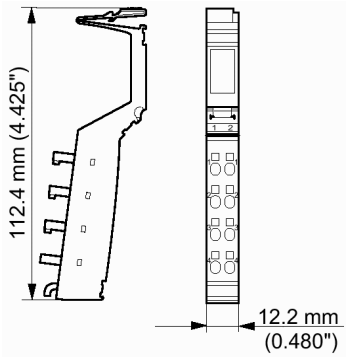
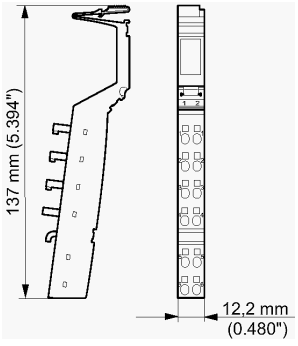
Module Dimensions

A VersaPoint positioning module has the following dimensions without connectors installed:

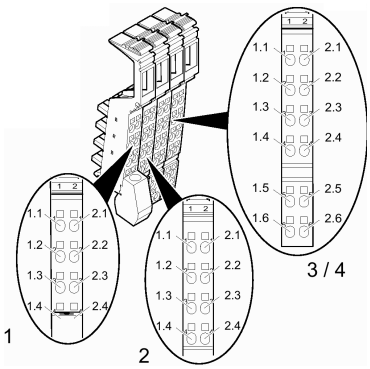


A VersaPoint positioning module can be installed in a standard control box with a depth of 80mm (3.150in). The housing must accommodate both the electronics base and the connectors.

With the connectors, the module has a depth of 71.5mm (2.815in) and a height of 132mm (5.197in) (height of the shield connector).

Shield Connector	***Standard Connector***	***Extended Connector***
		

Terminal Assignments



Encoders, sensors and actuators are connected to the modules using Connector Set IC220TBK202. The set includes a shield connector, a standard connector and two extended double signal connectors.

Terminal assignments for both VersaPoint Positioning modules are listed below:

Connector	Terminal	Signal	Assignment		
1 Shield connector	1.1	24V	+24VDC encoder supply		
	1.2	GND	Reference ground for the encoder supply		
	1.3	5V	+5VDC encoder supply		
	1.4	Shield	Shield connection (high resistance and capacitance to FE))		
		Signal	**IC220MDD841**	**Signal**	**IC220MDD842**
	2.1	–	not used	A*	Channel A* (asymmetrical)
	2.2	–	not used	B*	Channel B* (asymmetrical)
	2.3	–	not used	Z*	Channel Z* (asymmetrical)
	2.4	–	not used	Shield	Shield connection (high resistance and capacitance to FE)
2 Standard connector	1.1	T	Clock	A	Channel A (symmetrical)
	2.1	T	Clock inverted	A	Channel A (symmetrical) Inverted
	1.2	D	Data	B	Channel B* (symmetrical)
	2.2	D	Data inverted	B'	Channel B (symmetrical) Inverted
	1.3	–	Not used	Z	Channel Z (symmetrical)
	2.3	–	Not used	Z'	Channel Z (symmetrical) Inverted
	1.4, 2.4	–	Not used		
3 Extended double signal connector	1.1	IN1	Input 1		
	2.1	IN2	Input 2		
	1.2, 2.2	24V	Supply voltage +24VDC (UM)		
	1.3, 2.3	GND	GND of the supply voltage		
	1.4	IN3	Input 3		
	2.4	OHP	Enable Operator Hand Panel mode		
	1.5, 2.5	24V	Supply voltage +24VDC (UM)		
	1.6, 2.6	GND	GND of the supply voltage		
4 Extended double signal connector	1.1	OUT1	Output 1		
	2.1	OUT2	Output 2		
	1.2, 2.2	GND	GND of the supply voltage		
	1.3, 2.3	FE	Functional earth ground		
	1.4	OUT3	Output 3		
	2.4	OUT4	Output 4		
	1.5, 2.5	GND	GND of the supply voltage		
	1.6, 2.6	FE	Functional earth ground		

Connections for Encoders, Inputs, and Outputs

Please refer to the installation instructions in your NIU user manual for general information about connecting shielded and unshielded cables to a VersaPoint terminal strip.

Encoder Connections

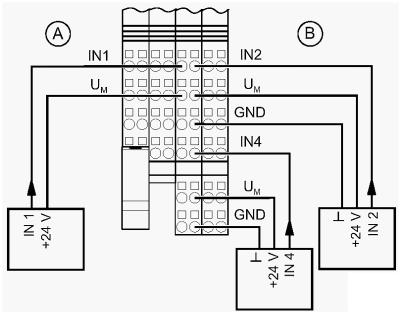
As shown on the previous page, encoder power and signal connections are made to the two leftmost connectors on the positioning module. Always connect encoders to the module using **shielded** cables. Unshielded cables may lead to erroneous results in environments that are prone to interference. On the module side, the shield is capacitively connected to the functional earth ground (FE) via the shield connector. On the encoder side, the shield must be connected to the grounded encoder housing.

Connect the encoder using the shield connector, and all other cables using connectors without shield connection.

Input Connections

Connections for inputs such as sensors, an optional Operator Hand Panel, or other digital inputs, are made to the third connector on the module. Sensors can be connected using the following methods:

- 2-wire (signal and 24V)
- 3-wire (signal, 24V, and GND)



2-Wire Connections

The left side above (A) shows the connection of a 2-wire sensor. The sensor signal is carried to module point IN1. Sensor power is supplied from the voltage U_M.

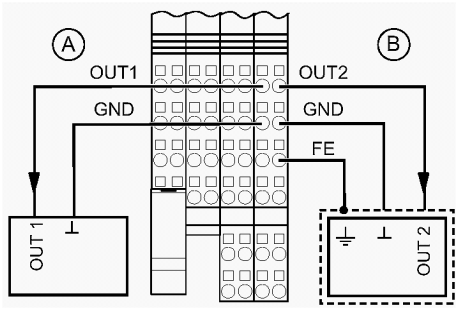
3-Wire Connections

The right side above (B) shows the connection of two 3-wire sensors. The sensor signals are carried to module points IN2 and IN4. The sensors are supplied with power using the module points U_M and GND.

Output Connections

Actuators or other digital outputs can be connected to the rightmost connector on the module using the following methods:

- 2-wire (signal and GND)
- 3-wire (signal, GND, and FE)



2-Wire Connections

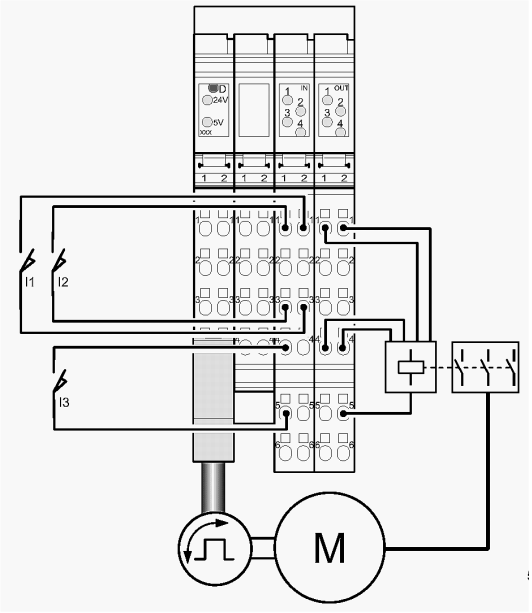
The left side above (A) shows the connection of a 2-wire actuator. The actuator power is supplied through output OUT1. The load is switched directly by the output.

3- Wire Connections

The right side above (B) shows the connection of a shielded actuator. The actuator power is supplied through output OUT2. The load is switched directly by the output.

The 500mA maximum current carrying capacity for each output must not be exceeded.

Example Sensor and Actuator Connections



By default, the module inputs have the following assignments:

I1 Limit switch 1 (minimum limit switch)

I2 Limit switch 2 (maximum limit switch)

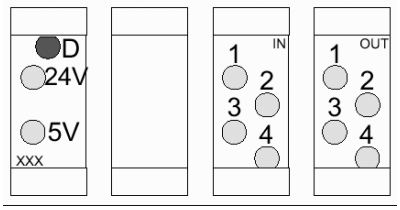
I3 Home position switch

Actual assignment of the inputs and outputs can be changed to suit the application. The module must also be configured to reflect the input/output setup using commands from the system host. This is detailed in chapter 4. See: *Configure Initiators and Switching Outputs* command.

Using Operator Hand Panel Mode

An optional Operator Hand Panel Mode can be used during startup. If used, it is connected to connector 3 on the module. The Operator Hand Panel sends commands directly to the drive. Although the limit switches are monitored and this is indicated in the module data, the limit switches have no effect on the drive control.

Module LEDs



Diagnostics LEDs

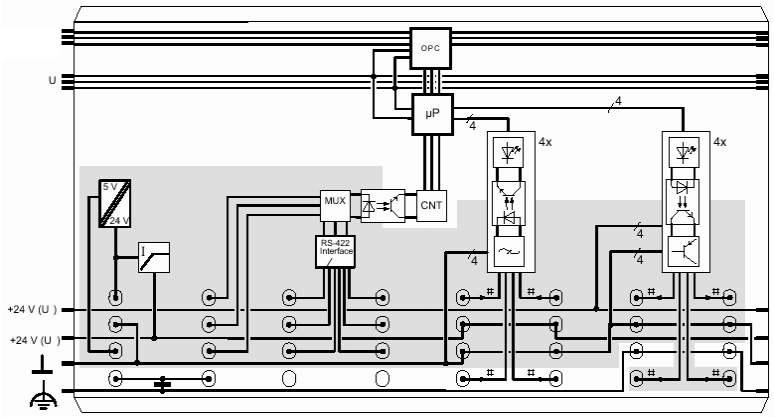
LED, Color	Meaning
D *Green*	*Bus diagnostics*
	On: Bus active
	Flashing 0.5Hz (slow): Communications power present, bus not active
	Flashing 2Hz (med): Communications power present, bus active, I/O error
	Flashing 4Hz (fast): Communications power present, bus connection to the module have failed; modules to the right are not configured
	Off: Communications power not present, bus not active
24V *Green*	*24V encoder supply*
	On: 24V encoder supply present
	Off: 24V encoder supply not present
5V *Green*	*5V Encoder supply*
	On: 5V encoder supply present
	Off: 5V encoder supply not present

Input and Output Status LEDs

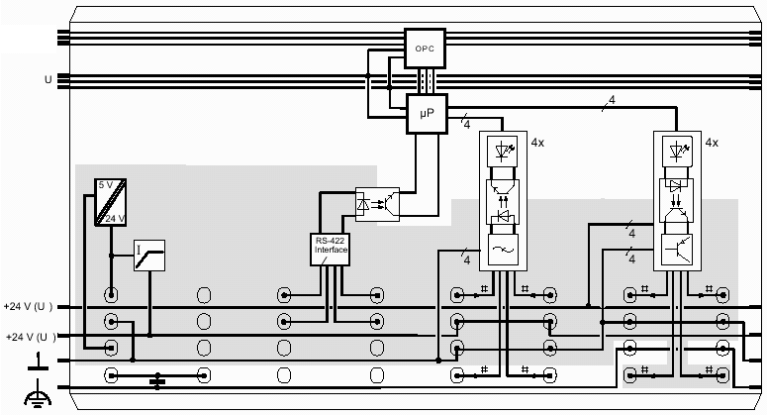
LED, Color	Meaning
Slot 3 *1, 2, 3* *Yellow*	*Inputs*
	On: The corresponding input is set
	Off: The corresponding input is not set
Slot 3, LED 4	Operator Hand Panel Mode active (LED on) or not active (LED off)
Slot 4 *1, 2, 3, 4* *Yellow*	*Outputs*
	On: The corresponding output is set
	Off: The corresponding output is not set

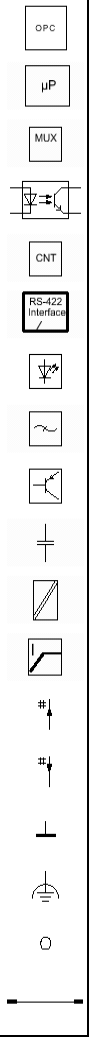
Internal Circuit Diagrams

Absolute Encoder Module IC220MDD841



Incremental Encoder Module IC220MDD842





bus logic
microprocessor
multiplexer
optocoupler
counter
RS-422
LED(s)
Filter
Transistor
Capacitor
Power supply
Encoder supply
Discrete input
Discrete output
Ground
Functional earth
ground
Module Point

Chapter 3

Module Input and Output Data

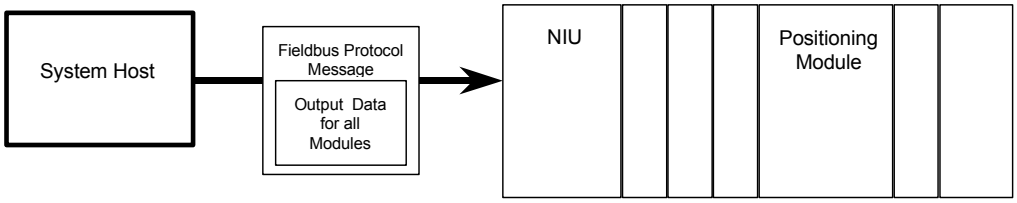
This chapter explains how a system host sends commands to a positioning module in a VersaPoint I/O Station, and then receives input data from the module.

- Exchanging Data with a Positioning Module
- Format of the Output Words
- Output Commands for Positioning Modules
- Output Command Sequencing
- Format of the Input Words
- Example Command Sequences

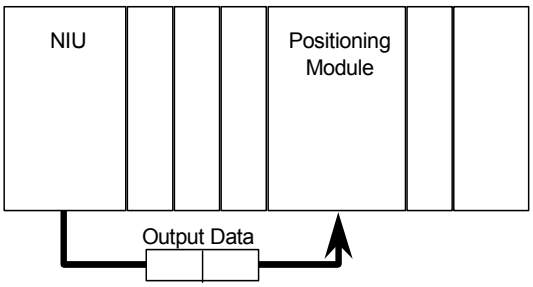
Exchanging Data with a Positioning Module

A system host exchanges data with the Network Interface Unit in a VersaPoint I/O Station using the appropriate bus protocol (for example, Profibus or DeviceNet). Protocol details are described in the each Network Interface Unit User's Manual.

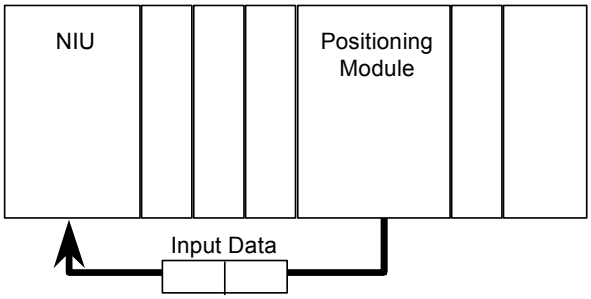
Regardless of the bus protocol, the actual content of the module data exchanged between the host and the NIU is the same. Each output message from the host contains all of the output data for the I/O Station. A positioning module receives two words of output data from the host as part of this message.



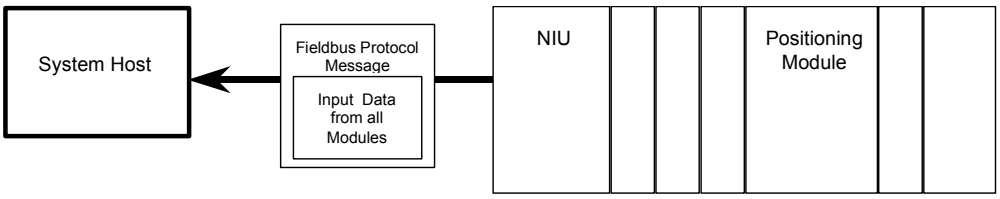
The system host must sequence the data to reflect the data type and module order. The NIU places the data in its own memory, then regularly sends the output data to the modules. The content of the data itself is not meaningful to the NIU.



A positioning module interprets the two words of output data it receives from the NIU as one of the commands described in this manual. The module then performs the commanded function, then sets the content of its two input data words accordingly. The NIU regularly reads this input data from the module and stores it in memory. Again, the input data is not meaningful to the NIU.



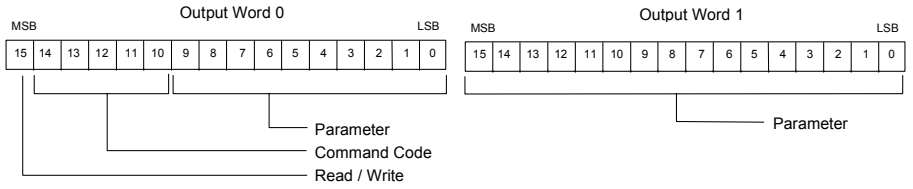
The system host that is controlling the I/O Station must read the input data from the NIU. After sending a command to a positioning module, the system host should wait for the input data from the module before sending its next command.



Because of the asynchronous processing times of the host, the network, the NIU, and the module itself, if the host sent commands too rapidly, the output data in the NIU might be overwritten before the NIU could send it to the module.

Format of the Output Words

The two words of output data for a positioning module have the following format:


Output Word 0
MSB
LSB
15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0
Output Word 1
MSB
LSB
15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0
Parameter
Command Code
Read / Write
Parameter

Read / Write	This bit specifies whether the command is to be written (1) to the module, or read (0) from it.
Command Code	Commands for the positioning modules are summarized on the next page, and described in the next three chapters.
Parameters	Most commands have additional parameters in the rest of the output bits. If the command has no associated parameters, these bits are not meaningful.

Assuring Data Consistency for the Output Commands

When sending output commands, it is important to ensure a data consistency of two words (32 bits) to prevent the possibility of misinterpretation of the values. Output word 1 must be written first, followed by output word 0, so the module can ensure the required data consistency.

Using Hexadecimal Data

The command descriptions in this manual represent the contents of the two output words and two inputs words in binary format, in order to show the positions of the parameter bits. It is also possible to send or read data in hexadecimal format.

Signed and Unsigned Data in Words

If the computer system handles bit data as one or two 16-bit words, unused significant bits in the data words should be filled as described below .

For signed values, significant unused bits should be filled to match the state of the sign bit. For example, a signed 26-bit value is stored in two 16-bit words of memory (data is located in bits 0 to 24):

- if the sign bit is 0, then bits 25 to 31 must also be set to 0
- if the sign bit is 1, then bits 25 to 31 must also be set to 1

For an unsigned value, the most significant free bits must be set to 0.

For example, for an unsigned 10-bit value stored in one 16-bit word of memory:

- bits 0 to 9 contain the value, and bits 10 to 15 must be set to 0

Output Commands for Positioning Modules

The table below lists output commands for the positioning modules. The commands are identified in bits 15 to 10. For each write command (codes in column 1), there is an equivalent command (codes in column 2), that can be used to read the current information from the module.

Bits 15...10		Command
Write	Read	
Module Configuration Commands		
1001 00	0001 00	Configure Encoder / Read Encoder Configuration
1001 01	0001 01	Configure / Read Initiators and Switching Inputs
System Configuration Commands		
1001 10	0001 10	Define / Read drive stop
1001 11	0001 11	Define / Read drive starting delay and output short-circuit time
1010 00	0010 00	Define / Read Increment evaluation
1010 01	0010 01	Absolute Encoder Module (MDL841): Define / Read logic offset
		Incremental Encoder Module (MDL842): Define / Read Reference Point
1010 10	0010 10	Define / Read minimum software limit switch
1010 11	0010 11	Define / Read maximum software limit switch
1011 00	0011 00	Absolute Encoder Module: Define / Read encoder offset
		Incremental Encoder Module: Define / Read Modulo Value for Rotary Axes
	0011 11	Read firmware version
Traverse Path Parameter Commands		
1100 00	0100 00	Define / Read start range for Parameter Record 1
1110 00	0110 00	Define / Read start range for Parameter Record 2
1100 01	0100 01	Define / Read rapid start range for Parameter Record 1
1110 01	0110 01	Define / Read rapid start range for Parameter Record 2
1100 10	0100 10	Define / Read rapid shutdown range for Parameter Record 1
1110 10	0110 10	Define / Read rapid shutdown range for Parameter Record 2
1100 11	0100 11	Define / Read pre-shutdown range for Parameter Record 1
1110 11	0110 11	Define / Read pre-shutdown range for Parameter Record 2
1101 00	0101 00	Define / Read shutdown range for Parameter Record 1
1111 00	0111 00	Define / Read shutdown range for Parameter Record 2
1101 01	0101 01	Define / Read target range for Parameter Record 1
1111 01	0111 01	Define / Read target range for Parameter Record 2
1101 10	0101 10	Define / Read target position for Parameter Record 1
1111 10	0111 10	Define / Read target position for Parameter Record 2
1101 11	0101 11	Define / Read friction correction value for Parameter Record 1
1111 11	0111 11	Define / Read friction correction value for Parameter Record 2
Control Commands		
	0000 00	Read Position
1000 00		Control Positioning and Read Position
	0000 10	Read Status
1000 10		Control Positioning and Read Status
	0000 11	Read Position of Reference Mark
1000 11		Control Positioning and Read Position of Reference Mark

Format of the Input Words

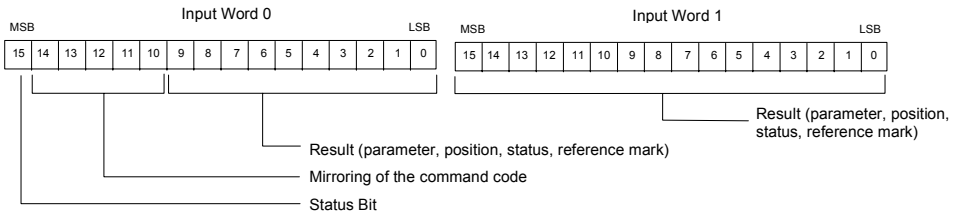
A positioning module provides two words of input data to the Network Interface Unit, where it can be read by the system host.

Input Words during Module Operation

While the system is operating, the two words of input data reflect the present states of the module's four inputs.

Input Words during Parameterization

During parameterization, the inputs mirror the output words that have been received from the NIU (command code, and if applicable, appropriate parameters).


Input Word 0
MSB
LSB
15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0
Input Word 1
MSB
LSB
15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0
Result (parameter, position, status, reference mark)
Result (parameter, position, status, reference mark)
Mirroring of the command code
Status Bit

If the command being mirrored had no parameters, the bits of the second input word are not meaningful.

Status Bit

Bit 15 of word 0 acts as a status bit. If bit 15 = 0, the command has been processed successfully.

If bit 15 of word 0 is = 1, then one of the following errors has occurred:

- The module has not yet been completely configured
- There is an invalid parameter in the default operating mode
- A reserved bit is set

The NIU can identify the error that occurred by issuing a *Read Status* command, which is described in chapter 6.

Command Sequencing

The host must send output commands to the module in the appropriate sequence: first configuration commands, then commands to set up the traverse paths, then control commands.

Setup commands are not stored by the module if communications power is lost. After power is restored, configuration and parameterization commands must be sent again.

1. Configuration Commands

The first commands to be sent are the configuration commands, which are defined in chapter 5. There are several types of configuration commands, and not all are needed in every application.

Configure Encoder Command

Use the Configure Encoder command to set up the module properly for the type of encoder operation required.

- for an Incremental Encoder Module, this command sets up:
  - Encoder Type (symmetrical, asymmetrical, voltage)
  - Homing with or without Z signal
  - Limit frequency of the encoder signal
  - Reverse meaning of encoder's direction of rotation
- for an Absolute Encoder Module, this command sets up:
  - Parity check for encoder
  - Code: Binary or gray code
  - Encoder resolution
  - Reverse meaning of encoder's direction of rotation

Configure Initiators and Switching Outputs

Use this command to define the type of axis (linear, rotary), and to set up the operation of the module inputs and outputs.

- Axis type (linear, rotary one direction, rotary both directions)
- Operation of outputs after reset
- Operation of initiators (limit switch, home position switch, start positioning with parameter record 1 or 2, digital input only)
    - Operation of switching outputs (select a version 1 - 4 to set up outputs speed (creeping, fast, rapid) and direction of motion (positive, negative), or version 5 to enable output control by commands.)

System Configuration Commands

Use the System Configuration commands to:

- Define Drive Stop (drive stop time and distance)
- Define Drive Start Delay time and Output Short-Circuit time
- Define Increment Evaluation (define units for measurement)
- Define Software Limit Switches (maximum, minimum)
- Define Logic Offset, Absolute Encoder Module: IC220MDL841
- Define Encoder Offset, Absolute Encoder Module
- Define Reference Point, Incremental Encoder Module: IC220MDL842
- Define Modulo Value for Rotary Axes, Incremental Encoder Module
- Read Firmware Version

2. Commands to Define the Traverse Paths

Two independent traverse paths can be defined for a VersaPoint Positioning module. For each traverse path, chapter 6 explains how to define:

- Start Range and Rapid Start Range
- Rapid Shutdown Range, Pre-Shutdown Range, and Shutdown Range
- Target Range and Target Position
- Friction correction value

3. Commands to Control Positioning

During operation, the system host can use the output commands described in chapter 7 to control operation of the module's outputs and to read position and status information from the module. The three Control commands all perform the same control functions for both types of VersaPoint positioning modules:

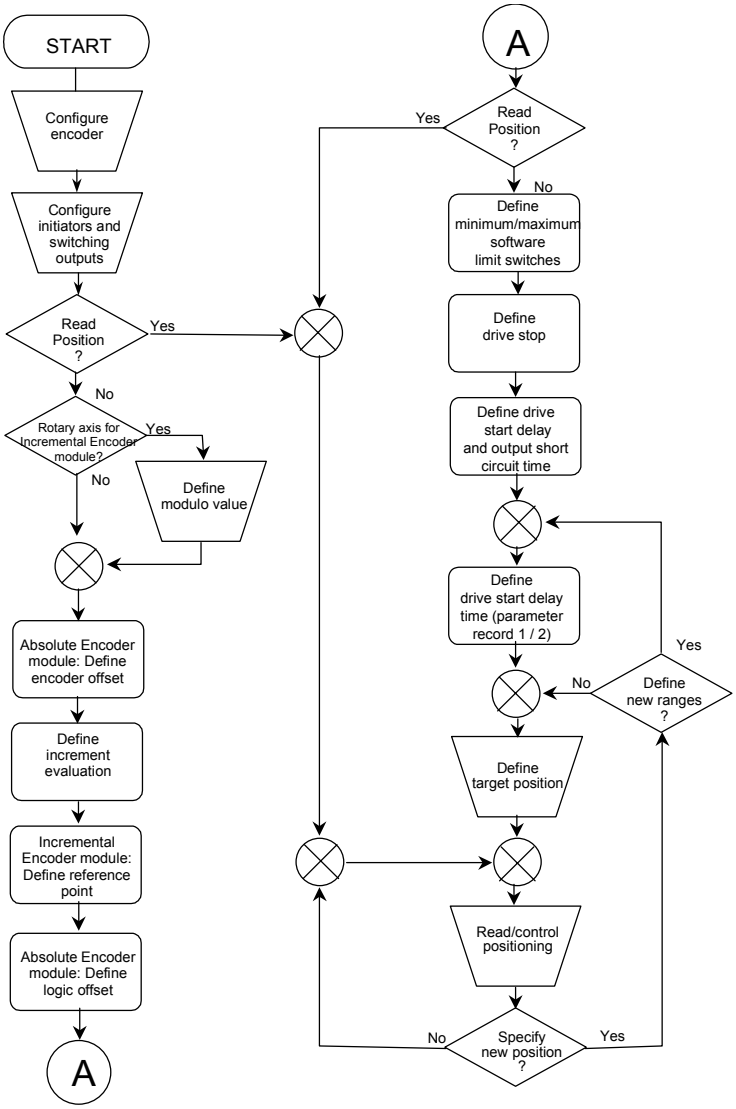
- Command outputs if output version 5 has been selected.
- Select negative or positive jog at creeping speed.
- Delete the Reference Mark flag in the input words
- Activate lubrication and friction compensation
- Enable looping
- Define starting direction for active backlash compensation or looping
- Activate backlash compensation
- Enable the start of the positioning process
- Start the positioning process
- Acknowledge an error message
- Stop positioning immediately

An Incremental Encoder module responds to the following additional commands:

- Enable rapid motion for homing
- Define direction from which reference point is started
- Set reference point
- Start homing

Overview of an Output Command Sequence

The diagram below represents a sequence of output commands that might be sent to a positioning module. It does not include all possible commands that might be sent, and is intended only as an example. In addition to sending output commands as shown here, the system host also must monitor the input data it receives from the module, as described next in this section.



Example Command Sequences

Command Sequence Example 1: Reading a Position

This example lists a simple exchange of data to:

1. configure the encoder
2. configure the initiators and switching outputs
3. read the position

Host Command, Output Data	Module Reply, Input Data
Delete command code	
Command: *Configure encoder* ▪ Encoder type: symmetrical (5V) ▪ Homing: with Z signal ▪ Limit frequency: 500 kHz ▪ Reversal of direction of rotation: OFF	Module returns mirror of command
Wait for acknowledgment from module	
Command: *Configure initiators and switching outputs* ▪ Initiator 1: limit switch ▪ Initiator 2: limit switch ▪ Initiator 3: home position switch ▪ Switching outputs: version 2 Adjust the switching outputs to your application. ▪ Reset: stops a positioning in process ▪ Axis type: linear axis	Module returns mirror of command
Wait for acknowledgement from module	
Command: *Read Position*	Module returns the current position

Command Sequence Example 2: Reading a Position Using Increment Evaluation

This example lists an exchange of data to:

1. configure the encoder
2. configure the initiators and switching outputs
3. define increment evaluation
4. define a logic offset or reference point, depending on the module type
5. read the position taking increment evaluation into consideration

Host Command, Output Data	*Module Reply, Input Data*
Delete command code	
Command: *Configure encoder* ▪ Encoder type: symmetrical (5V) ▪ Homing: with Z signal ▪ Limit frequency: 500 kHz ▪ Reversal of direction of rotation: OFF	Module returns mirror of command
Wait for acknowledgment from module	
Command: *Configure initiators and switching outputs* ▪ Initiator 1: limit switch ▪ Initiator 2: limit switch ▪ Initiator 3: home position switch ▪ Switching outputs: version 2 Adjust the switching outputs to your application. ▪ Reset: stops a positioning in process ▪ Axis type: linear axis	Module returns mirror of command
Wait for acknowledgement from module	
Command: *Define Increment Evaluation* ▪ Target position: 1000	Module returns mirror of command
Wait for acknowledgement from module	
Command for Absolute Encoder Module (MDD841): *Define Logic Offset* ▪ Set logic offset to 0	Module returns mirror of command
Command for Incremental Encoder Module (MDD842): *Define Reference Point* ▪ Set reference point to 0	
Wait for acknowledgement from module	
Command: *Read Position*	Module returns the current position

Command Sequence Example 3: Approaching a Position

The example lists an exchange of data to:

1. configure the encoder
2. configure the initiators and switching outputs
3. define the target position
4. set the current position as a reference point
5. start positioning and read the command status

Host Command, Output Data	*Module Reply, Input Data*
Delete command code	
Command: *Configure encoder* ▪ Encoder type: symmetrical (5V) ▪ Homing: with Z signal ▪ Limit frequency: 500 kHz ▪ Reversal of direction of rotation: OFF	Module returns mirror of command
Wait for acknowledgment from module	
Command: *Configure initiators and switching outputs* ▪ Initiator 1: minimum limit switch ▪ Initiator 2: maximum limit switch ▪ Initiator 3: home position switch ▪ Switching outputs: version 2 Adjust the switching outputs to your application. ▪ Reset: stops a positioning in process ▪ Axis type: linear axis	Module returns mirror of command
Wait for acknowledgement from module	
Command: *Define Target Position* ▪ Target position: 1000	Module returns mirror of command
Wait for acknowledgement from module	
Command: *Control Positioning and Read Status* ▪ Set current position as a reference point	Module returns status information
Wait for acknowledgement	
Command: *Control Positioning and Read Status* ▪ Start positioning with parameter record 1 (approach position 1000) (This example does not include range parameterization, so it would not provide precision positioning.)	Module returns status information
Wait for acknowledgement from module	

Chapter 4

Configuration Commands

This section describes the commands used to configure VersaPoint positioning modules.

- Module Configuration Commands:
  - *Configur*e Encoder/Read Encoder Configuration
  - Configure/*Read Initiators and Switching Outputs*
- System Configuration Commands:
  - *Define/Read* Drive Stop (drive stop time and distance)
  - Define/Read Drive Start Delay and Output Short-Circuit Time
  - Define/Read Increment Evaluation (define units for measurement)
  - Define/Read Software Limit Switches (maximum, minimum)
  - For the Absolute Encoder Module, IC220MDL841:
    - *Defi*ne/Read Logic Offset
    - Define*/Read Encoder Offset*
  - For the Incremental Encoder Module, IC220MDL842:
    - *Defi*ne/Read Reference Point
    - Defi*ne/Read Modulo Value* for Rotary Axes
- Read Firmware Version

This section also describes each command's read version, which can be used to read the configuration parameter from the module.

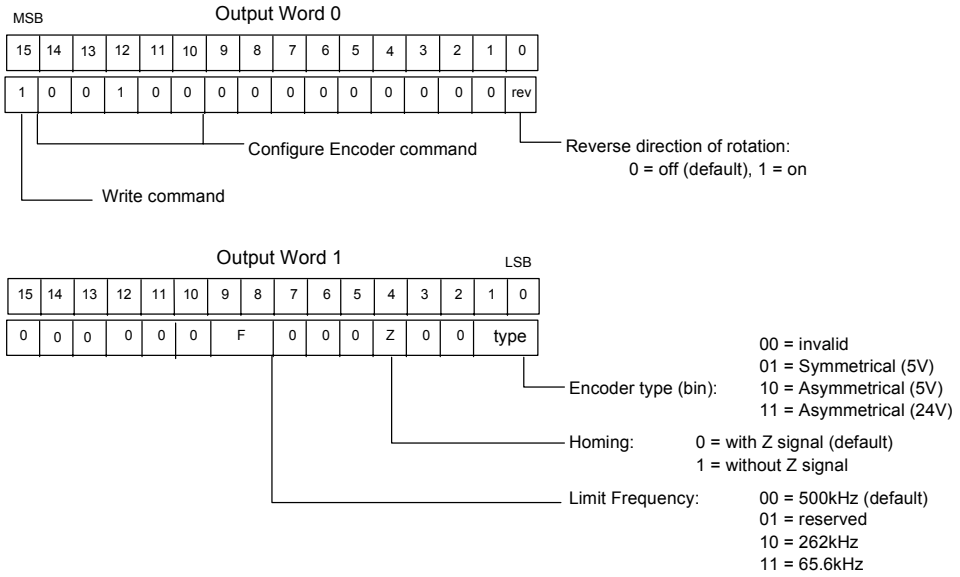
Reconfiguring the Module After Loss of Communications Power

If there is a loss of communications power on the module, configured parameters are *not* saved. The module must be reconfigured after switching on the communications power.

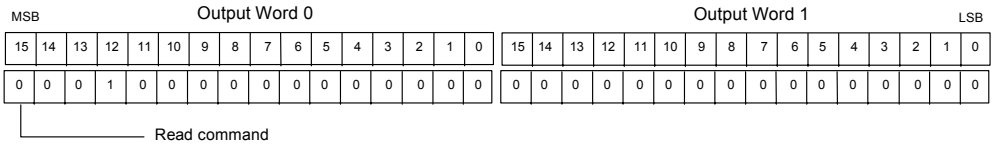
Configure Encoder Command: Incremental Encoder Module

Use this command to define the operation of the encoder used with an Incremental Encoder Module (IC220MDD842).

Format of the Configure Encoder Command

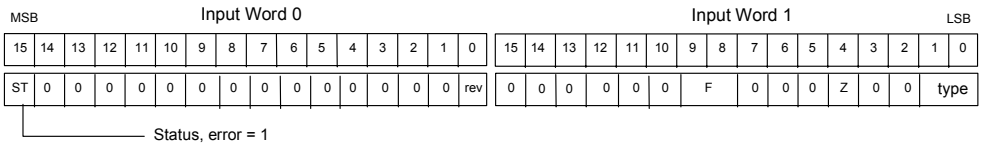

MSB
Output Word 0
15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0
1 0 0 1 0 0 0 0 0 0 0 0 0 0 0 rev
Configure Encoder command
Reverse direction of rotation:
0 = off (default), 1 = on
Write command
Output Word 1
LSB
15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0
0 0 0 0 0 0 F 0 0 0 Z 0 0 type
Encoder type (bin):
00 = invalid
01 = Symmetrical (5V)
10 = Asymmetrical (5V)
11 = Asymmetrical (24V)
Homing:
0 = with Z signal (default)
1 = without Z signal
Limit Frequency:
00 = 500kHz (default)
01 = reserved
10 = 262kHz
11 = 65.6kHz

Format of the Read Encoder Configuration Command



Read Encoder Configuration Reply from the Module

See the bit definitions above.



Reversal of Direction of Rotation (default is off)

The Reversal parameter can be used to invert the *interpretation* of the encoder code sequence. For example, data from an encoder that has an ascending code sequence on positive rotation of the axis can be set up so that during negative rotation, the same code sequence is interpreted as descending. This parameter makes it possible to use one encoder on both sides of an axis without changing the range limits.

Limit Frequency (default is 500)

It is possible to limit the bandwidth of the encoder signal using a digital filter. The limit frequency affects the noise immunity of the application. Adjust the limit frequency to the number of increments per second of your application. We recommended setting the limit frequency to the lowest possible value. For example:

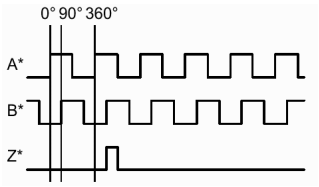
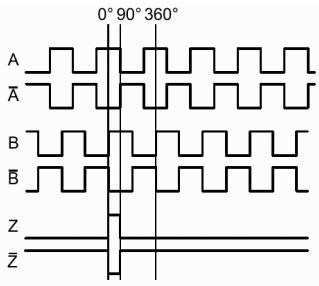
Encoder: 720 increments per rotation (INC/U)
Shaft: 1200 rotations per minute (60 rotations per second (U/s))
60 INC/U x 720 U/s = 43,200 INC/s = 43.2 kHz

For this example, the limit frequency must be set to 65.5kHz (11_{bin}). However, for 65.6 kHz, the next highest limit frequency must be set (262 kHz, which is 10_{bin}).

Homing (default is Homing with Z Signal)

Incremental encoders cannot return the absolute position after power up, so a position must be defined using the homing process. During operation, homing is started by setting a control bit in the module's output words. During homing, the zero point signal (Z signal) of the incremental encoder is used to synchronize the actual value with a fixed reference point in the positioning range. If homing without a Z signal is selected, the module homes directly to the negative or positive edge of the home position switch.

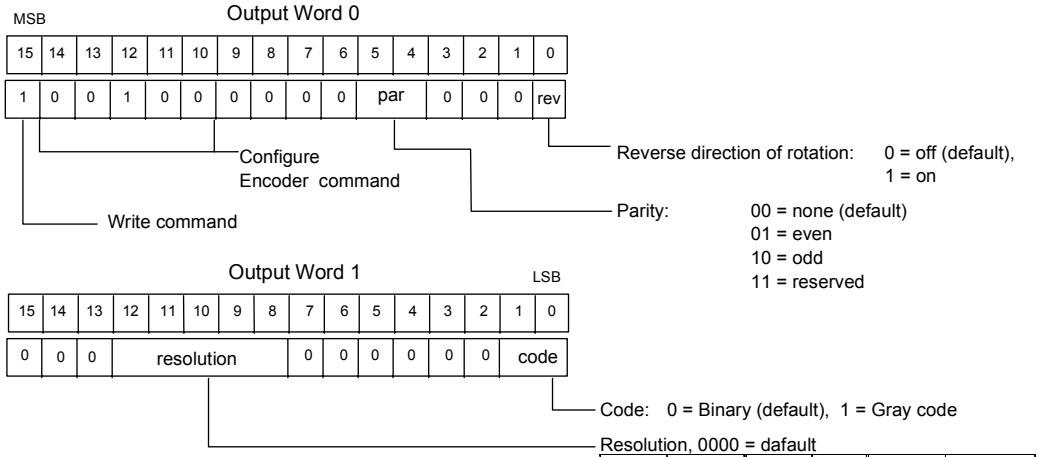
Encoder type (no default, a type must be specified)

	The pulse image of an **asymmetrical** encoder consists of signals A* and B* set at 90°, and the zero pulse Z*. An output signal of 360° is formed by a pulse (180°), and a pause (180°). Asymmetrical encoders with 5V or with 24V encoder supply can be connected to the Incremental Encoder Module.
	A **symmetrical** encoder produces an inverted signal ($\bar{A}$, $\bar{B}$, $\bar{Z}$) for every signal (A, B, Z). Inverted signals reduce the effect of interference. Only connect symmetrical encoders according to specification RS-422, otherwise the interface may be damaged. For example, an encoder has a symmetrical signal up to ±30V. Connecting this encoder to the symmetrical interface would damage the interface. However, the same encoder could be connected to the **asymmetrical** interface using its A, B, and Z signals. Module points A, B, and Z would not be used in this case.

Configure Encoder Command: Absolute Encoder Module

Use this command to define the operation of the encoder used with an Absolute Encoder Module (IC220MDD841)

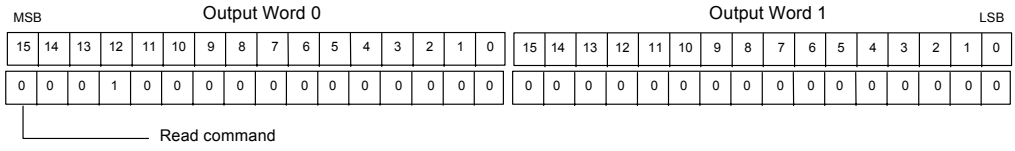
Format of the Configure Encoder Command)


MSB
Output Word 0
15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0
1 0 0 1 0 0 0 0 0 0 par 0 0 0 rev
Configure Encoder command
Write command
Reverse direction of rotation: 0 = off (default), 1 = on
Parity: 00 = none (default) 01 = even 10 = odd 11 = reserved
Output Word 1
LSB
15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0
0 0 0 resolution 0 0 0 0 0 0 code
Code: 0 = Binary (default), 1 = Gray code
Resolution, 0000 = dafault

00000	Invalid	00111	14	01110	21
00001	8	01000	15	01111	22
00010	9	01001	16	10000	23
00011	10	01010	17	10001	24
00100	11	01011	18	10010	25
00101	12	01100	19	10011	26 *
00110	13	01101	20	10100 - 11111	Re-served

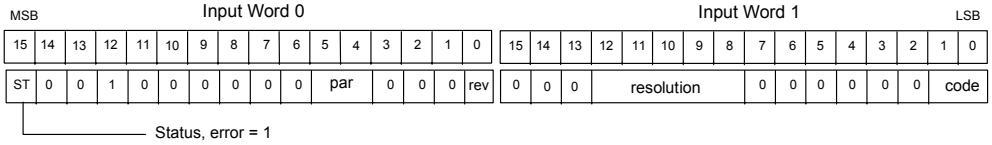
*Area of representation: -2^{25} to $+2^{25} - 1$

Format of the Read Encoder Configuration Command



Read Encoder Configuration Reply from the Module

See the bit definitions above.



Parameter Descriptions

Parity (default is none)

If parity checking is configured for an encoder that supports the function, the module checks when the current actual position is determined. If an error occurs twice in succession during this parity check, the module generates an error message with the error code 5_{dec} "Parity error occurred".

Reversal of Direction of Rotation (default is reversal off)

The Reversal parameter can be used to invert the *interpretation* of the encoder code sequence. For example, data from an encoder that has an ascending code sequence on positive rotation of the axis can be parameterized so that during negative rotation the same code sequence will interpreted as descending.

This parameter makes it possible to use one encoder on both sides of an axis without changing the range limits.

Resolution (invalid default, must be specified)

The resolution configured for the Absolute Encoder Module must correspond to the resolution of the absolute encoder that is being used.

For example, a multi-turn encoder is set with the 12 bits/12bits parameter. This encoder specifies a position as:

- the number of rotations (represented in 12 bits)
- the resolution per rotation (represented in 12 bits)

The resolution is therefore 24 bits (12 bits + 12 bits).

Code (default is binary)

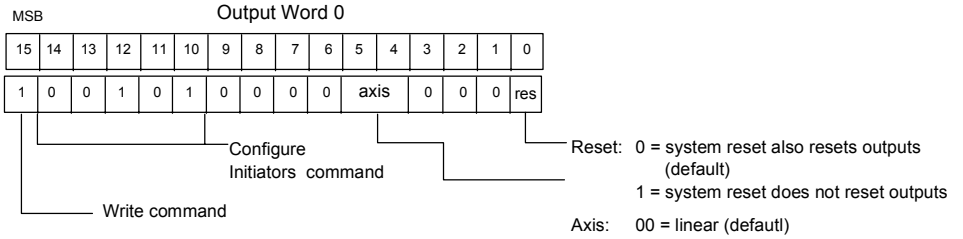
An encoder operates in Gray code or binary code, depending on the type. Set the code parameter accordingly.

Configure/Read Initiators and Switching Outputs Command

This command configures the basic operation of the module:

- axis type
- assignment of the module initiators (inputs)
- assignment of the module outputs
- effect of a reset

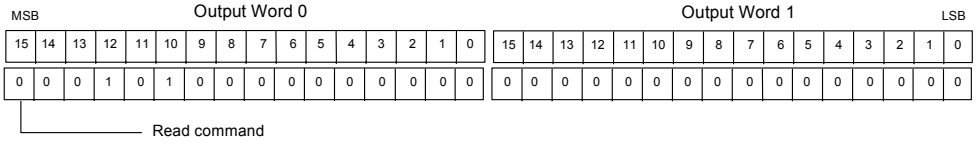
Format of the Configure Initiators and Switching Outputs Command


MSB
Output Word 0
15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0
1 0 0 1 0 1 0 0 0 0 axis 0 0 0 res
Configure Initiators command
Write command
Reset: 0 = system reset also resets outputs (default)
1 = system reset does not reset outputs
Axis: 00 = linear (defautl)
01 = rotary, negative direction only
10 = rotary, positive direction only
11 = rotary, both directions
Output Word 1
LSB
15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0
0 sout 0 initiator 3 0 initiator 2 0 initiator 1
See the descriptions that follow in the text
Switching outputs: (000 is default)

000	Invalid	100	version 4
001	version 1	101	version 5
010	version 2	110	reserved
011	version 3	111	reserved

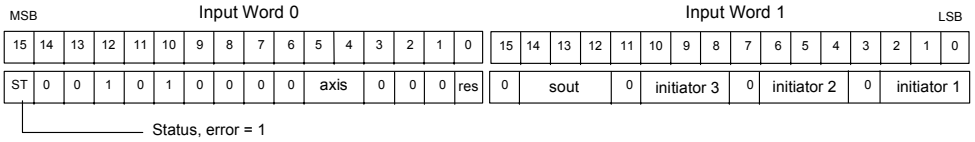
Descriptions follow in the text

Format of the Read Initiators and Switching Outputs Command



Read Initiators and Switching Outputs Reply from the Module

See the bit definitions above.


MSB
Input Word 0
Input Word 1
LSB
15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0
15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0
ST 0 0 1 0 1 0 0 0 0 axis 0 0 0 res
0 sout 0 initiator 3 0 initiator 2 0 initiator 1
Status, error = 1

Selecting Behavior during Reset (default is to reset outputs)

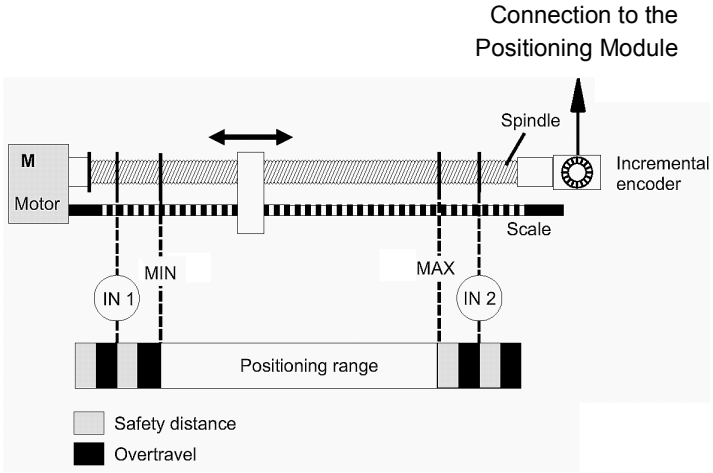
If the Reset bit is set to 0, a system reset also resets the switching outputs and stops a running positioning process. If this bit is set to 1, a reset has no effect on positioning and the positioning processes can be started using the inputs.

Defining the Axis Type (default is linear)

Specify a linear axis for any axis with a limited positioning range. That includes a rotary axis if the drive is not freely-rotatable.

Linear Axis

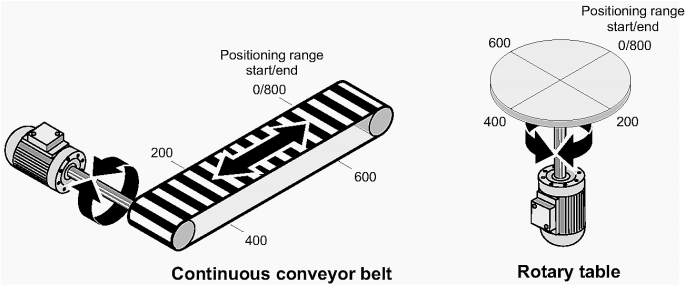
The positioning range of a linear axis is limited by the configured software limit switches and/or hardware limit switches.



IN 1	Limit position 1
IN 2	Limit position 2
MIN	Minimum software limit switch
MAX	Maximum software limit switch

Rotary Axis

A rotary axis is an axis with an unlimited positioning range (such as a rotary table or a continuous conveyor belt). Its beginning and end of the range is the same physical point on the axis.



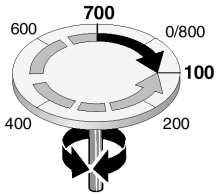
If rotary axis mode is active, the drive must be freely rotate-able. If the drive does not rotate freely, the axis must be parameterized as a linear axis.

Hardware and software limit switches are not used for a rotary axis. Limitations can be specified with reference to the direction of travel. There are rotary axes that only turn in a negative or in a positive direction, and rotary axes that turn in both directions. The permissible traversing directions are defined using thi*s* command.

The maximum positioning range for a rotary axis is determined by a modulo value. The modulo value can be specified using the *Define Modulo Value* command as explained later in this chapter. In the example above, the modulo value is specified as 800. This value has the same position on the axis as the value 0. The actual value range is indicated by the module as 0 to 799. The value 800 is not indicated.

Path Optimization for a Rotary Axis

For a rotary axis that can travel in both a positive and a negative direction, the traversing direction is selected so that the target position is reached using the shortest path. For example, on a rotary table, the positioning range (modulo value) is set to 800. The current position is 700 and the specified target position is 100. If it is possible to travel in a positive and a negative direction, the table takes the shortest path to position 100, via the start/end of the positioning range (0/800).

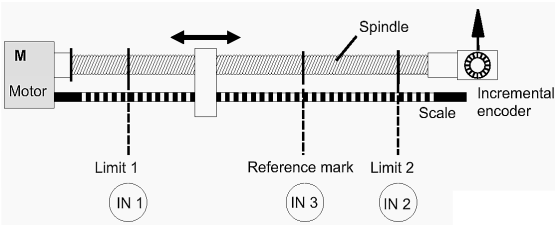


If travel were only permitted in the negative direction, the table would travel from position 700 through positions 600, 400, and 200 to position 100.

Setting Up the Inputs (Initiators)

Use the three groups of initiator bits to assign the functions of inputs 1, 2, and 3. By default, the module's inputs have the following assignments:

I1 Limit switch 1 (minimum limit switch)
I2 Limit switch 2 (maximum limit switch)
I3 Home position switch



The defaults can be changed as shown below.

If positioning will be controlled by a parameter record and started using a command from the system host, then set up an input as a control input.

Inputs can also be used for other types of digital signals (for example, if the module is used only to read position and not to control positioning).

Initiator 1 *(default is 000)*	***Switch Active When:***	***Word 1 Bits 2-0***
Minimum limit switch	Set to 1	000
	Set to 0	100
Minimum limit and home switch position	1 to 0 transition	001
	0 to 1 transition	101
Control input: Start positioning with parameter record 1	0 to 1 transition	010
	1 to 0 transition	110
None (only digital input)	Set to 1	011
	Set to 0	111
Initiator 2 *(default is 000)*	***Switch Active When:***	***Word 1 Bits 6-4***
Maximum limit switch	Set to 1	000
	Set to 0	100
Maximum limit and home switch position	1 to 0 transition	001
	0 to 1 transition	101
Control input: Start positioning with parameter record 2	0 to 1 transition	010
	1 to 0 transition	110
None (only digital input)	Set to 1	011
	Set to 0	111
Initiator 3 *(default is 000)*	***Switch Active When:***	***Word 1 Bits 10-8***
Home Position Switch	1 to 0 transition	000
	0 to 1 transition	100
Control input: IC220MDD841: Start positioning with parameter record 2 IC220MDD842: Reserved	0 to 1 transition	001
	1 to 0 transition	101
Control input: Start positioning with parameter record 1	0 to 1 transition	010
	1 to 0 transition	110
None (only digital input)	Set to 1	011
	Set to 0	111

Setting Up the Outputs (a version must be selected)

The module's outputs control the traversing rate and direction of the drive. It is important to configure the outputs correctly to avoid damage to the system. If the module is being used only for position detection, only its encoder connections (connectors 1 and 2) are used for positioning signals, and the input and output connections can be used for other digital I/O devices. Five different combinations of switching operation can be commanded using these three bits. Depending on the version chosen, setting a specific output to 0 or 1 *during system operation* determines how that output is used. For example, if version 1 or 2 operation has been set up here, then setting output 1 to 1 during operation enables positive rapid motion and negative rapid motion at that output. However, if version 3 is chosen, then setting output 1 to 1 during operation enables positive rapid motion only.
If the outputs should be freely controllable from the system host using positioning commands, then version 5 output operation must be set up here.

State During Operation	Output 1	Output 2	Output 3	Output 4
Switching Outputs, Version 1:				
Stop	0	0	0	0
Positive creeping motion	0	1	1	0
Positive rapid motion	1	1	1	0
Negative creeping motion	0	1	0	1
Negative rapid motion	1	1	0	1
Switching Outputs, Version 2:				
Stop	0	0	0	0
Positive creeping motion	0	1	1	0
Positive rapid motion	1	0	1	0
Negative creeping motion	0	1	0	1
Negative rapid motion	1	0	0	1
Switching Outputs, Version 3:				
Stop	0	0	0	0
Positive creeping motion	0	1	0	0
Positive rapid motion	1	0	0	0
Negative creeping motion	0	0	1	0
Negative rapid motion	0	0	0	1
Switching Outputs, Version 4:				
Stop	0	0	0	0
Brake	0	0	1	1
Positive creeping motion	1	0	0	0
Positive rapid motion	1	1	0	0
Positive fast motion	1	1	1	0
Negative creeping motion	1	0	0	1
Negative rapid motion	1	1	0	1
Negative fast motion	1	1	1	1
Switching Outputs, Version 5:				
Controllable via control command	OUT 1	OUT 2	OUT 3	OUT 4

Define/Read Encoder Offset Command, Absolute Encoder Module

These commands are used only with the Absolute Encoder module (IC220MMDD841).

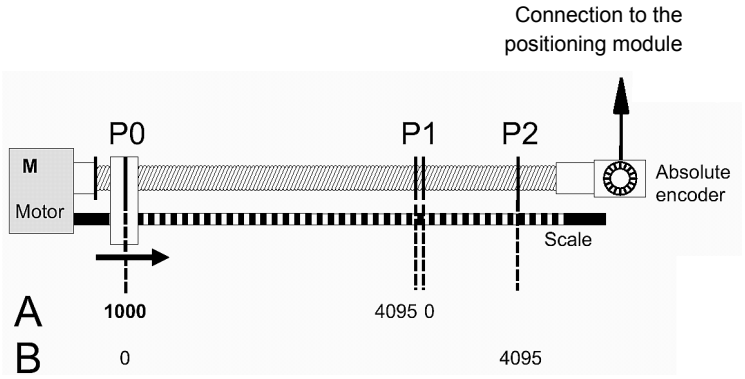
An encoder offset shifts the data representation for the encoder, and can compensate for an encoder that is not set to the zero position. The encoder offset must be defined *before* defining the increment evaluation.

Note that an encoder offset, which reassigns an offset to be the zero position, is not the same as a logic offset, which reassigns the zero position to be an offset value.

It is possible to define the encoder offset with a value that is not equal to the read position. However, that limits the operating range.

Example of Encoder Offset

In this example, the encoder has a resolution of 12 bits. Therefore a range from 0 to 4096 increments can be used.



The encoder has been installed and the drive is in the presumed zero position (P0 above).

First, the *Read Position* command is used to read the current position. For this example, it is determined that the zero position is equal to 1000. If the drive travelled through position 4095 (P1 in the illustration above), a "Counter overflow" error would occur and it would not be possible to approach position P2. To use the entire range of 4096 increments, position P0 should have the value 0.

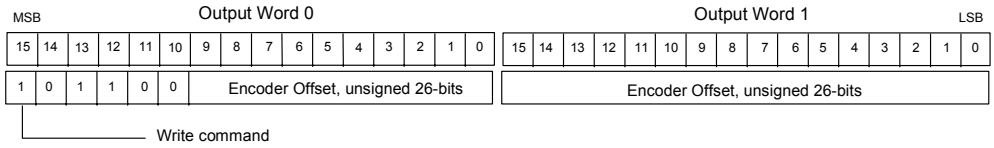
The encoder could be removed and turned backward. Alternatively, the *Define Encoder Offset* command can be used to assign the actual position to be the zero value. In this example, the encoder offset is defined to be 1000.

Encoder Offset Values

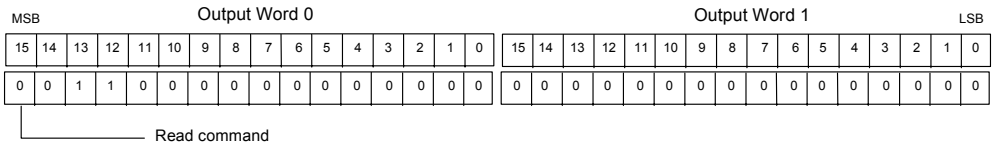
The encoder offset is specified as a 26-bit value. The value for the encoder offset must not exceed the resolution of the encoder.

Decimal	*Offset Value*
0	No encoder offset (default)
1 to 2^{26}-1	1 increment to 2^{26}-1 increments

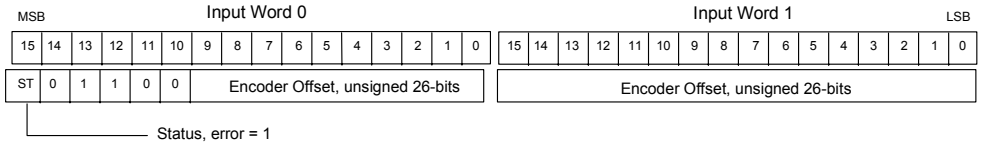
Format of the Define Encoder Offset Command


MSB
Output Word 0
Output Word 1
LSB
15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0
15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0
1 0 1 1 0 0 Encoder Offset, unsigned 26-bits
Encoder Offset, unsigned 26-bits
Write command

Format of the Read Encoder Offset Command



Read Encoder Offset Reply from the Module


MSB
Input Word 0
Input Word 1
LSB
15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0
15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0
ST 0 1 1 0 0 Encoder Offset, unsigned 26-bits
Encoder Offset, unsigned 26-bits
Status, error = 1

Define/Read Increment Evaluation Command

Increment evaluation makes it possible to define all paths in any defined units. The *Define Increment Evaluation* command specifies how many measurement units (for example, centimeters) correspond to a certain number of increments. The module performs increment evaluation by dividing the number of measurement units by the number of increments:

$$\frac{\text{units}}{\text{increments}}$$

The result must be less than 1.

For example, a path is 200 centimeters long, which represents 4000 increments, so:

$$\frac{\text{units}}{\text{increments}} = \frac{200\text{cm}}{4000\text{incr.}} = \frac{1}{20}$$

Incremental evaluation can be carried out for linear and rotary axes. Once an increment has been defined, all the following values must subsequently be specified in the selected units:

- Software limit switches
- Parameter records (startup range, rapid startup range, pre-shutdown range, shutdown range, target range, target position)
- Drive stop
- Reference point
- Logic offset

Caution

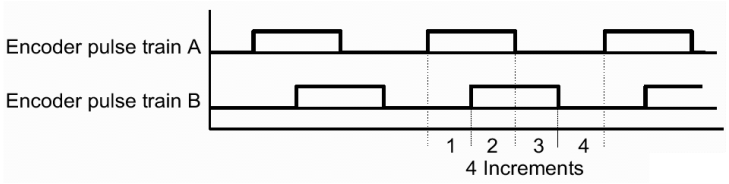
Do not carry out increment evaluation during operation. If the parameters specified above have not been defined for the selected increments, an increment evaluation entry or change during operation will lead to incorrect positioning.

Note

The module's cycle time is 500 microseconds. To implement positioning with a tolerance of ± one increment, the creeping speed should be set to less than one increment per millisecond.

Resolution of the Incremental Encoder Module

The positioning modules operate with what is known as quadruple scanning. For example, an encoder with 1024 pulses supplies 4096 pulses per rotation.



The resolution must be reduced using the increment evaluation as necessary (1/4, 1/2). This has no effect on the limit frequency of the encoder pulse trains. The maximum input frequency of A and B is 500kHz.

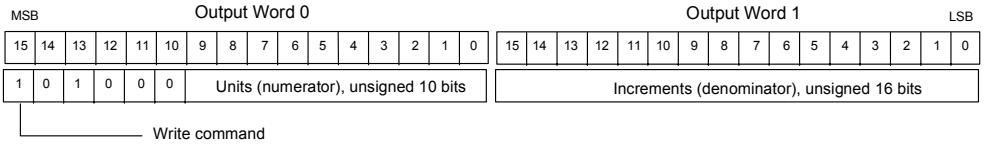
For the Absolute Encoder Module (IC220MDD841) resolution can be specified using the *Configure Encoder* command, as described earlier in this chapter.

Parameters for Increment Evaluation

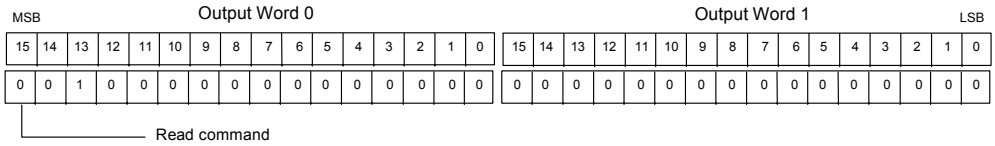
The units and increments must be derived from the application.

Units (numerator), decimal	1 to 1023	1 increment to 1023 increments (default is 1)
Increments (denominator), decimal	1 to 2^{16}-1	1 increment to 2^{16}-1 increments (default is 1)

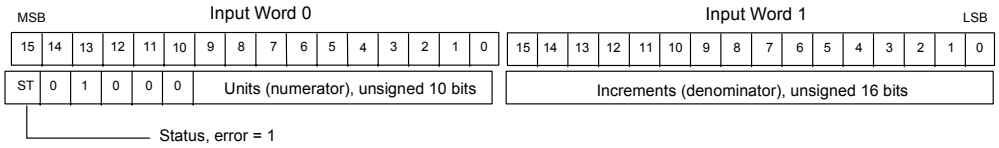
Format of the Define Increment Evaluation Command


MSB
Output Word 0
Output Word 1
LSB
15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0
15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0
1 0 1 0 0 0
Units (numerator), unsigned 10 bits
Increments (denominator), unsigned 16 bits
Write command

Format of the Read Increment Evaluation Command



Read Increment Evaluation Reply from the Module


MSB
Input Word 0
Input Word 1
LSB
15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0
15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0
ST 0 1 0 0 0 Units (numerator), unsigned 10 bits
Increments (denominator), unsigned 16 bits
Status, error = 1

Define/Read Drive Stop Command

A drive stop is defined by specifying a maximum distance that may be covered in a specified time interval. The module uses the speed threshold set in this command to monitor the drive during positioning, and to detect that the drive has stopped after being switched off.

Monitoring the Drive During Positioning

During positioning, the module checks whether the drive is running in the intended direction faster than the drive stop. If the specified distance is not covered within the specified time interval, the module sets the error status to "Drive Stop Detected" and the drive is switched off.

Detecting that the Drive Has Come To a Stop After Being Switched Off

After drive shutdown, the module checks whether the drive is moving less than the set increment in the predefined time. When the stop is detected, the stop bit is set to 1 (see: *Read Status and Control Positioning* Command in chapter 6).

Reading the Positioning Status Information

The application can use the *Read Status* command (see chapter 6) to read status after positioning. The status words will indicate that either:

- target range was reached, and the positioning process was completed successfully, or:
- the target range was not reached. In that case, the error bit is set and an error code is generated.

If drive stop monitoring is not active, the stop bit is constantly set.

Setting Up Drive Stop

Set the Drive Stop parameters to suit the application. To prevent the Drive Stop Detected message being triggered unnecessarily, please note the following:

- If the motor will start up against a large load or against a brake, a Drive Start Delay Time must also be defined. The *Define Drive Start Delay* command is described next in this chapter. When a start delay has been

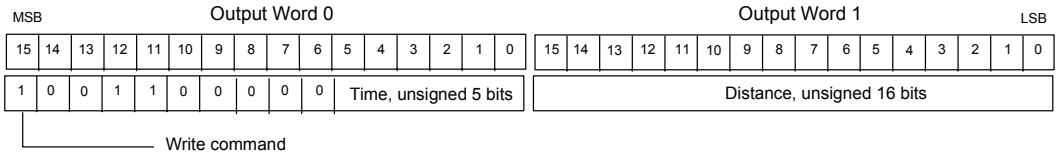
defined, if the drive starts moving within the drive start time, the Drive Stop Detected error message is not generated.

- If vibrations occur in the drive train, the time for the drive stop must be greater than the vibrations.
- After the drive stops, the module does not detect the stop until the specified time has passed (at most, this is double the specified time). Therefore, do not select a greater time than is necessary.

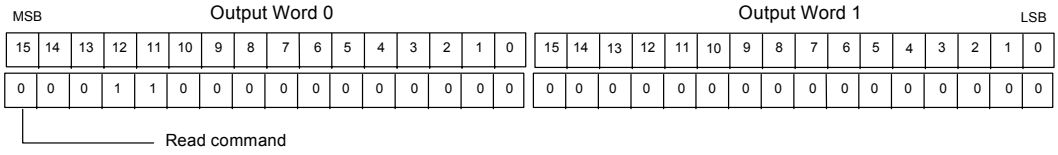
Parameters of the Define / Read Drive Stop Command

Time Interval (decimal)	0	No monitoring of the drive stop
	1 to 31	0.1s to 3.1s
	10	1second (default)
Distance (decimal)	0 to 2^{16}-1	0 Increments to 2^{16}-1 Increments
	1	1 Increment (default)

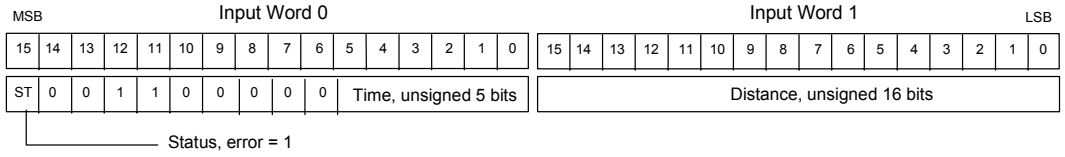
Format of the Define Drive Stop Command


MSB
Output Word 0
Output Word 1
LSB
15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0
15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0
1 0 0 1 1 0 0 0 0 0
Time, unsigned 5 bits
Distance, unsigned 16 bits
Write command

Format of the Read Drive Stop Command



Read Drive Stop Reply from the Module


MSB
Input Word 0
Input Word 1
LSB
15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0
15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0
ST 0 0 1 1 0 0 0 0 0
Time, unsigned 5 bits
Distance, unsigned 16 bits
Status, error = 1

Define/Read Drive Start Delay Time and Output Short-Circuit Time Command

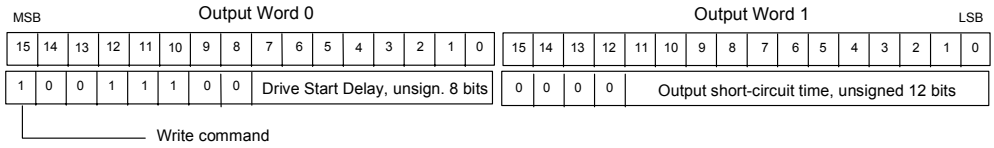
Drive start delay time is a period during which the monitoring for drive stop is deactivated. During this period, the system can start up during a positioning process without a stop being detected during active drive stop monitoring.

The short-circuit time provides short-circuit protection by setting outputs at the same time. The outputs for the traversing rate are switched shortly after the outputs for the traversing direction.

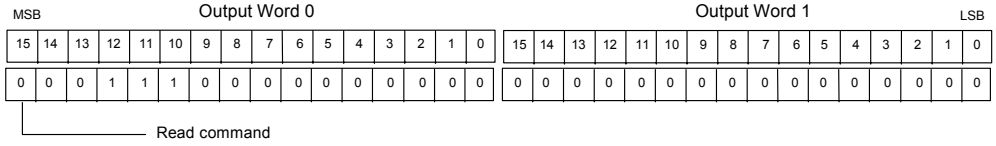
Parameters of the Define /Read Drive Start, Output Short Circuit Command

Drive Start Delay, decimal	0 to 255	0 seconds (default) to 25.5 seconds
Output Short-Circuit Time), decimal	0 to 4095	0ms to 4095ms
	10	10ms (default)

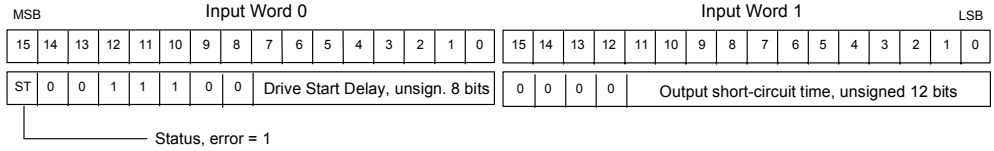
Format of the Define Drive Start and Output Short Circuit Time Command


MSB
Output Word 0
15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0
1 0 0 1 1 1 0 0 Drive Start Delay, unsign. 8 bits
Write command
Output Word 1
LSB
15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0
0 0 0 0 Output short-circuit time, unsigned 12 bits

Format of the Read Drive Start and Output Short Circuit Time Command



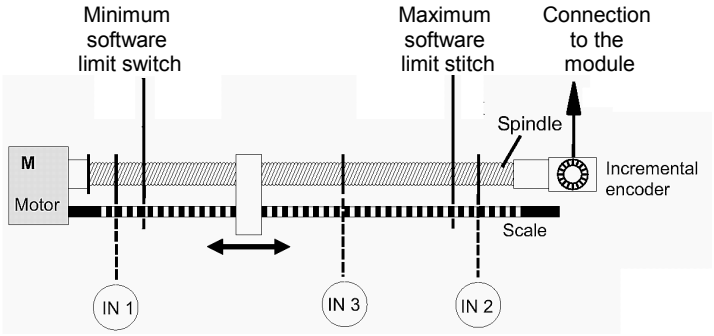
Read Drive Start and Output Short Circuit Time Reply from the Module


MSB
Input Word 0
15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0
ST 0 0 1 1 1 0 0 Drive Start Delay, unsign. 8 bits
Status, error = 1
Input Word 1
LSB
15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0
0 0 0 0 Output short-circuit time, unsigned 12 bits

Define/Read Software Limit Switches Commands

In addition to hardware limit switches, which can be connected to module inputs 1 and 2, software limit switches can be activated or deactivated using the *Define Software Limit Switches* command. Software limit switches prevent the drive from traveling to a position outside the software limits in normal mode, thus prevent it from driving right up to the limits (hardware limit switches).

Example of Software Limit Switches



IN 1 Limit position 1
IN 2 Limit position 2
IN 3 Home position switch

In rotary axis mode and for homing, software limit switches are deactivated.

For the Incremental Encoder Module (IC220MDD842), software limit switches take effect after homing. Since homing is not necessary for the Absolute Encoder Module (IC220MDD841), software limit switches take effect immediately.

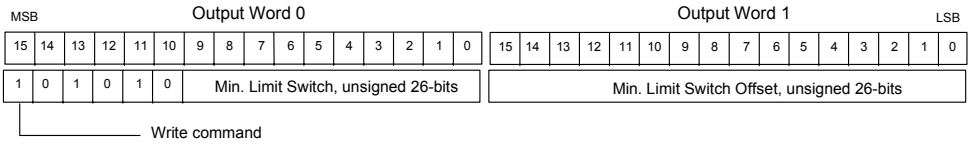
A check is made before positioning is started to determine whether the software limit switches will be overrun. If the target position is outside the software limit switches, the positioning is not started, and an error message is generated.

Software Limit Switch Values

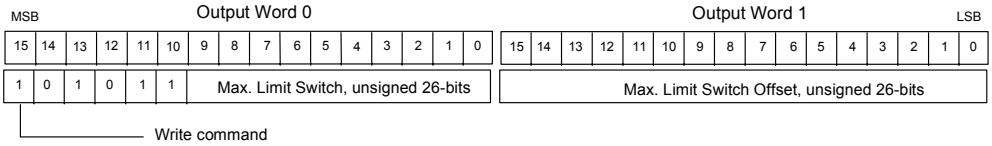
A software limit switch is a 26-bit unsigned decimal value. It may be:

Decimal	*Limit Switch Value*
-2^{25} to $+(2^{25}-1)$	-2^{25} increments (default minimum) to $+(2^{25}-1)$ increments (default maximum)

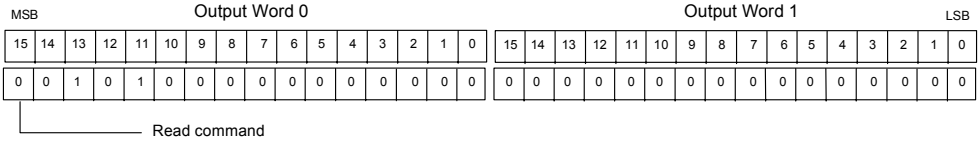
Format of the Define Minimum Software Limit Switches Command


MSB
Output Word 0
15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0
Output Word 1
15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0
LSB
1 0 1 0 1 0
Min. Limit Switch, unsigned 26-bits
Min. Limit Switch Offset, unsigned 26-bits
Write command

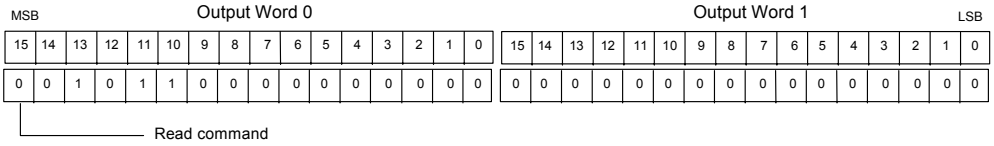
Format of the Define Maximum Software Limit Switches Command


MSB
Output Word 0
15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0
Output Word 1
15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0
LSB
1 0 1 0 1 1
Max. Limit Switch, unsigned 26-bits
Max. Limit Switch Offset, unsigned 26-bits
Write command

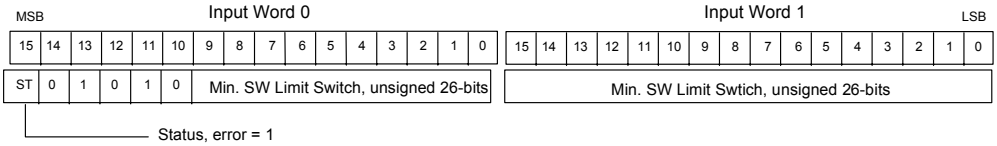
Format of the Read Minimum Software Limit Switches Command



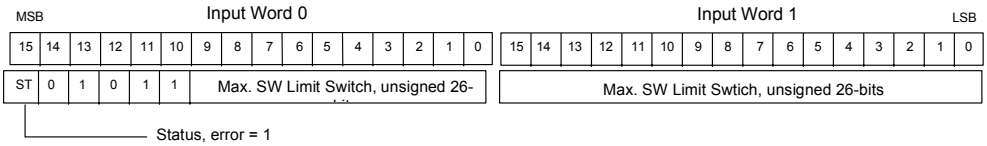
Format of the Read Maximum Software Limit Switches Command



Read Minimum Software Limit Switches Reply from the Module


MSB
Input Word 0
15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0
Input Word 1
15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0
LSB
ST 0 1 0 1 0
Min. SW Limit Switch, unsigned 26-bits
Min. SW Limit Swtich, unsigned 26-bits
Status, error = 1

Read Maximum Software Limit Switches Reply from the Module


MSB
Input Word 0
15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0
Input Word 1
15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0
LSB
ST 0 1 0 1 1
Max. SW Limit Switch, unsigned 26-
Max. SW Limit Swtich, unsigned 26-bits
Status, error = 1

Define/Read Logic Offset Command, Absolute Encoder Module

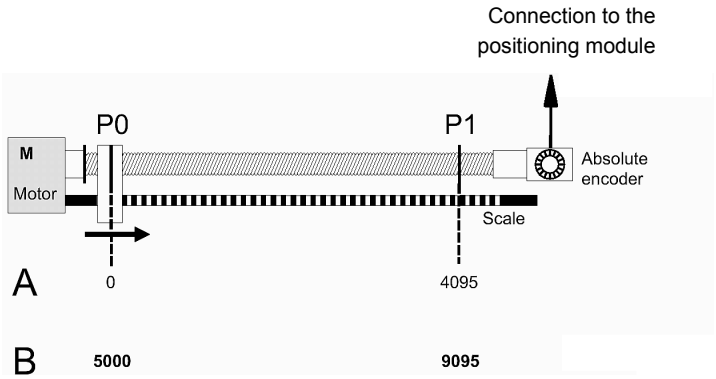
The Absolute Encoder module calculates the position of the drive based on the increments that have been configured and a logic offset. The logic offset must be defined *after* increment evaluation, because the logic offset must be entered in the appropriate units.

The logic offset is equal to the number of increments between the current position and an intended position. The current position can be read using the *Read Position* command as described in chapter 6. When determining the current position, the logic offset must be set to 0.

Note that a logic offset, which reassigns the zero position to be an offset value, is not the same as an encoder offset, which reassigns an offset to be the zero position.

Logic Offset Example

In this example, the encoder has a resolution of 12 bits. Therefore a range from 0 to 4095 increments can be used.



In this example, the encoder has been installed and the drive is in the zero position (P0 above). This state is either reached immediately or after defining the encoder offset. It is now possible to position within the range 0 and 4095 increments (line A above).

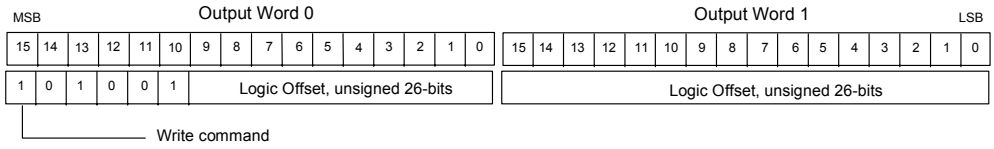
The positioning range can be shifted to another system of coordinates by defining a logic offset. For this example, a logic offset is defined to be 5000. The value range now has a range from 5000 to 9095 increments (B above).

Logic Offset Values

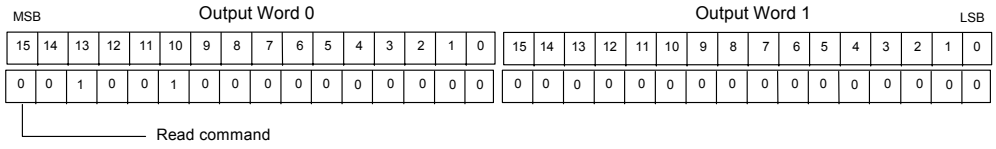
A reference point switch is a 26-bit unsigned decimal value. It may be:

Decimal	Logic Offset
-2^{25} to $+(2^{25}-1)$	-2^{25} increments to $+(2^{25}-1)$ increments
0	0 increments (default)

Format of the Define Logic Offset Command


MSB
Output Word 0
Output Word 1
LSB
15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0
15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0
1 0 1 0 0 1
Logic Offset, unsigned 26-bits
Logic Offset, unsigned 26-bits
Write command

Format of the Read Logic Offset Command



Read Logic Offset Reply from the Module

MSB
Input Word 0
Input Word 1
LSB
15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0
15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0
ST 0 1 0 0 1
Logic Offset, unsigned 26-bits
Logic Offset, unsigned 26-bits
Status, error = 1

Define/Read Reference Point Command, Incremental Encoder Module

There are two ways to determine the reference point:

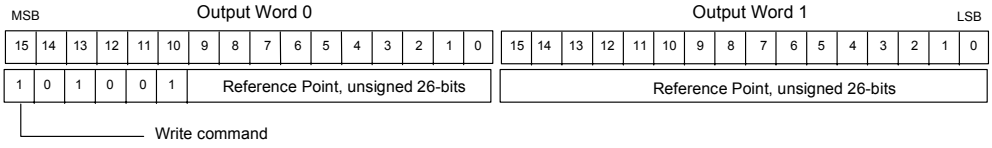
1. The position of the reference point can be set using homing.
2. You can specify the current position of the drive as a reference point. That can be done by setting bit 7 of output word 1 to 1 in one of the control commands described in chapter 6. This determined or defined position is assigned a value using the *Define Reference Point* command.

Reference Point Values

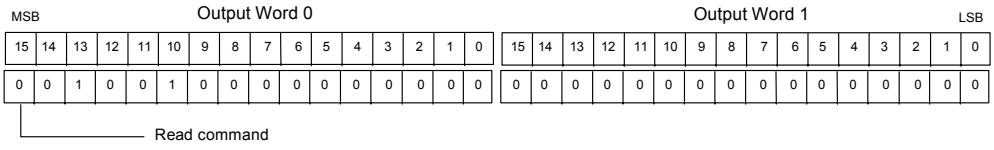
A reference point switch is a 26-bit unsigned decimal value. It may be:

Decimal	*Reference Point*
-2^{25} to $+(2^{25}-1)$	-2^{25} Increments to $+(2^{25}-1)$ increments
0	0 increments (default)

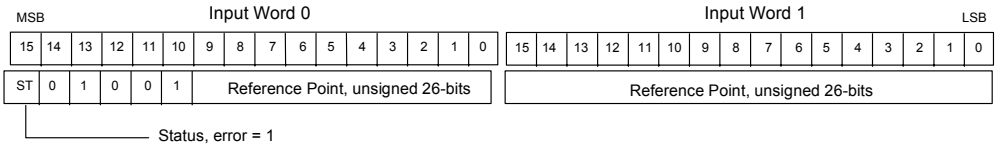
Format of the Define Reference Point Command


MSB
Output Word 0
Output Word 1
LSB
15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0
15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0
1 0 1 0 0 1
Reference Point, unsigned 26-bits
Reference Point, unsigned 26-bits
Write command

Format of the Read Reference Point Commands

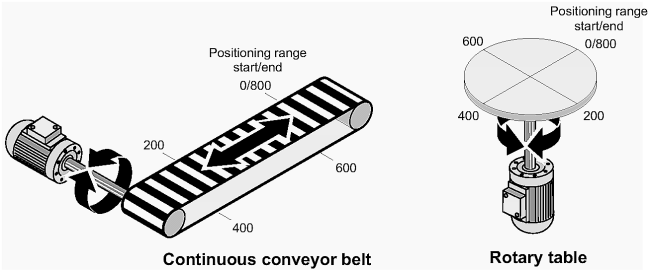


Read Reference Point Reply from the Module


MSB
Input Word 0
Input Word 1
LSB
15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0
15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0
ST 0 1 0 0 1
Reference Point, unsigned 26-bits
Reference Point, unsigned 26-bits
Status, error = 1

Define/Read Modulo Value Commands

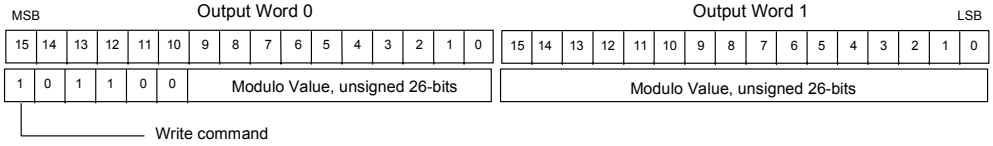
These commands are only used with the Incremental Encoder module (IC220MDD842) in rotary axis mode. The 26-bit modulo value determines the number of increments in the positioning range. For example:



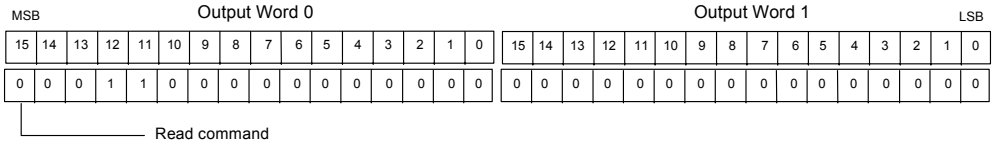
It may be:

Decimal	*Modulo Value*
1 to 2^{26}-1	1 increment to 2^{26}-1 increments
1000	1000 increments (default)

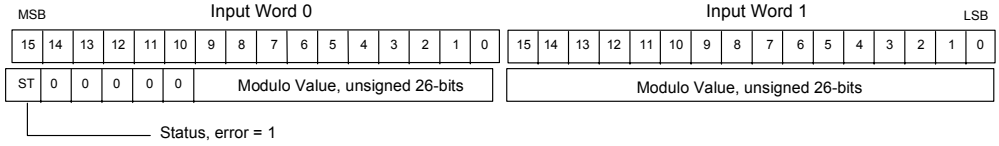
Format of the Define Modulo Value Command


MSB
Output Word 0
Output Word 1
LSB
15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0
15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0
1 0 1 1 0 0 Modulo Value, unsigned 26-bits
Modulo Value, unsigned 26-bits
Write command

Format of the Read Modulo Command



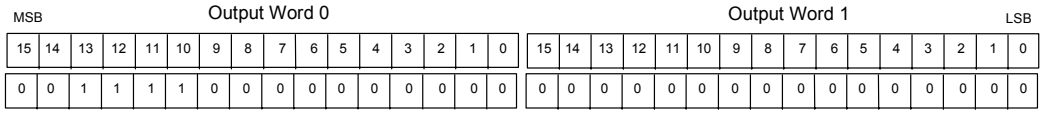
Read Modulo Reply from the Module


MSB
Input Word 0
Input Word 1
LSB
15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0
15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0
ST 0 0 0 0 0 Modulo Value, unsigned 26-bits
Modulo Value, unsigned 26-bits
Status, error = 1

Read Firmware Version Command

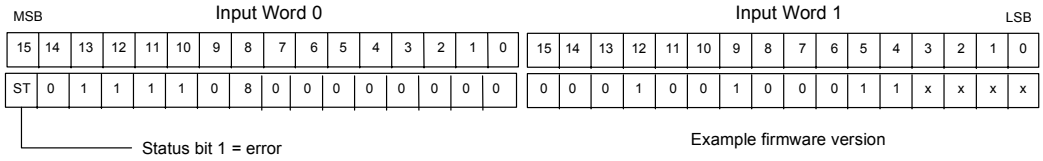
The firmware version of a VersaPoint Positioning module can be read at any time using the following command:

Format of the Read Firmware Version Command



Firmware Version Returned by the Module

The module immediately returns the firmware version in word 1 of its input data:



In this example, input word 1 has the value $123X_{hex}$. The firmware version is therefore 1.23. The value of bits 3 through 0 of input word 1 is irrelevant.

Chapter 5

Defining Parameter Records

This section describes output commands that can be used to define two independent traverse paths for a positioning module. The following parameters can be defined for each path:

- Start range
- Rapid start range
- Rapid shutdown range
- Pre-shutdown range
- Shutdown range
- Target range
- Target position
- Friction correction value

Changes made during a positioning process have no effect on the current positioning. The new values only take effect on the next positioning.

Identifying a Parameter Record

The two traverse paths are called Parameter Record 1 and Parameter Record 2. In the command, the parameter record being configured is identified in bit 13 of output data word 0.

- When defining parameters for Parameter Record 1, bit 13 of output word 0 = 0.
- When defining parameters for Parameter Record 2, bit 13 of output word 0 = 1.

Positioning with the Parameter Records

The module stores the Parameter Records defined here as part of its configuration. If power is lost, the system host must re-send the parameters.

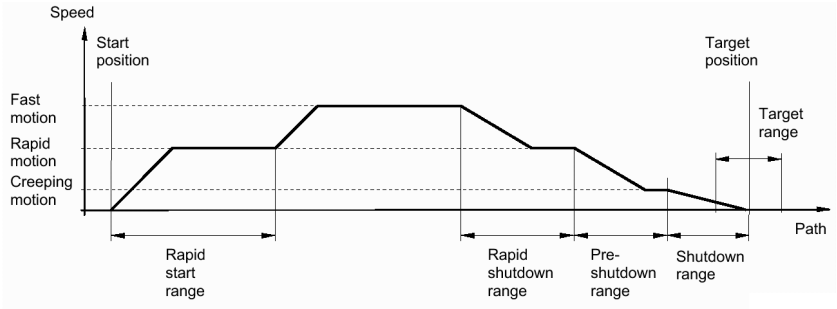
Positioning with Parameter Record 1 or 2 must also be set up using the *Define Initiators and Switching Outputs* command, as described in the previous chapter.

Positioning Steps

The parameters that can be defined with these commands depend on whether positioning is done with two or three speeds.

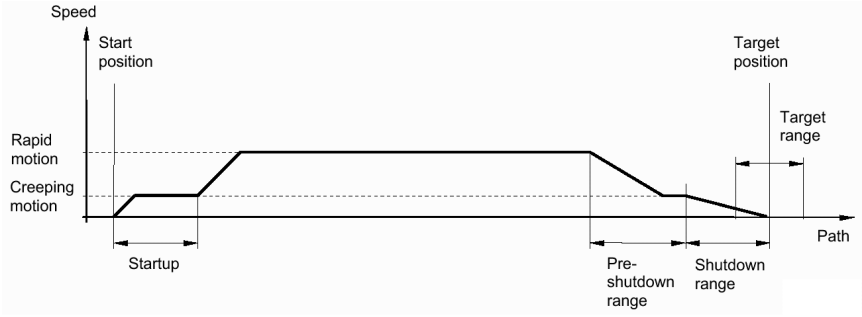
Steps of Positioning with Three Speeds

1. Start the drive and run in rapid motion (rapid start range).
2. Change the drive to fast motion.
3. Change the drive to rapid motion (rapid shutdown range).
4. Change the drive to creeping motion (pre-shutdown range).
5. Shut down the drive: roll to a stop in the target range.

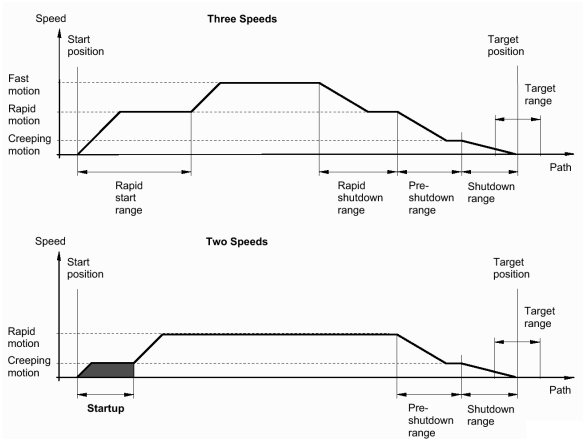


Steps of Positioning with Two Speeds

1. Start the drive and run in creeping motion (start range).
2. Change the drive to rapid motion.
3. Change the drive to creeping motion (pre-shutdown range).
4. Shut down the drive: roll to a stop in the target range.

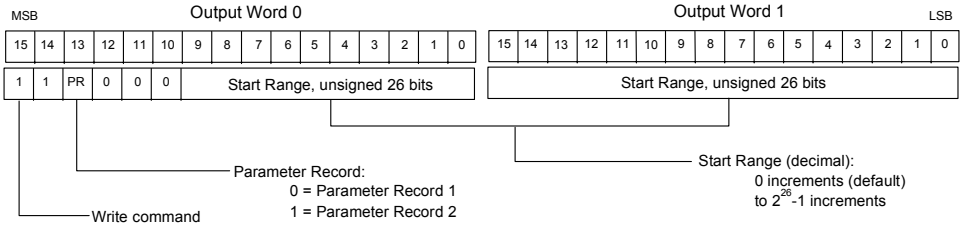


Define/Read Start Range Command

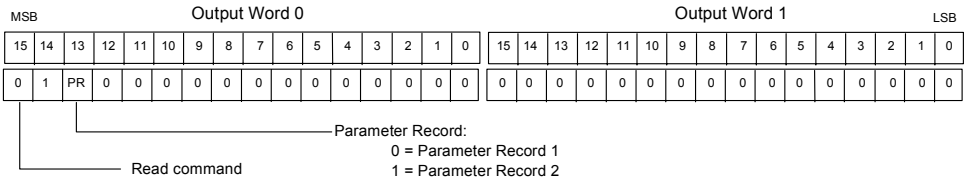


If output version 4 has been selected with the *Configure Initiators and Switching Outputs* command (see chapter 4), the start range is only used when running a loop (looping, backlash compensation).

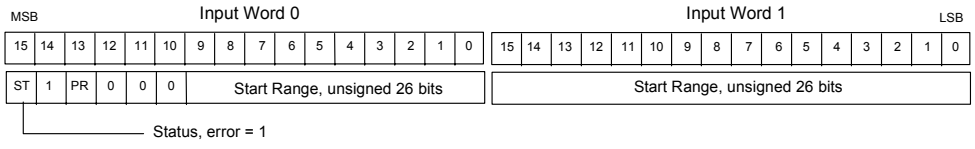
Format of the Define Start Range Command


MSB
Output Word 0
Output Word 1
LSB
15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0
1 1 PR 0 0 0 Start Range, unsigned 26 bits
Start Range, unsigned 26 bits
Start Range (decimal):
0 increments (default)
to 2^26 -1 increments
Parameter Record:
0 = Parameter Record 1
1 = Parameter Record 2
Write command

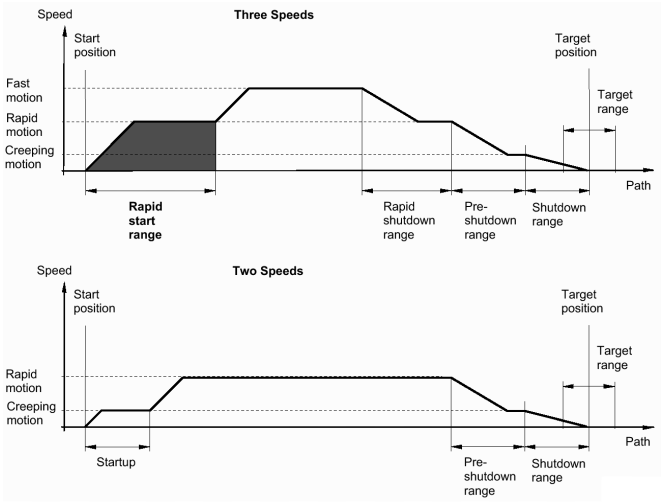
Format of the Read Start Range Command


MSB
Output Word 0
Output Word 1
LSB
15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0
0 1 PR 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
Parameter Record:
0 = Parameter Record 1
1 = Parameter Record 2
Read command

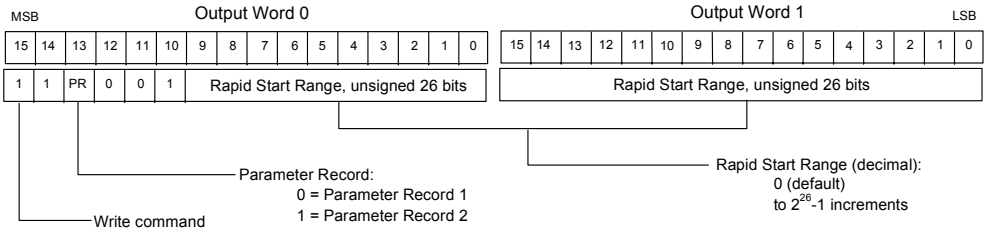
Read Start Range Reply from the Module


MSB
Input Word 0
Input Word 1
LSB
15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0
ST 1 PR 0 0 0 Start Range, unsigned 26 bits
Start Range, unsigned 26 bits
Status, error = 1

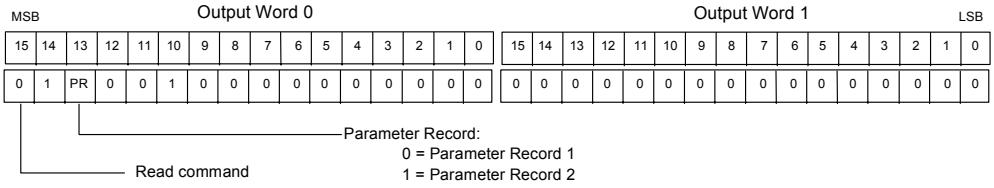
Define/Read Rapid Start Range Command



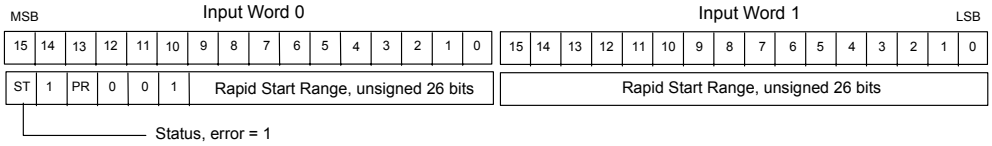
Format of the Define Rapid Start Range Command


MSB
Output Word 0
Output Word 1
LSB
15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0
1 1 PR 0 0 1
Rapid Start Range, unsigned 26 bits
Rapid Start Range, unsigned 26 bits
Parameter Record:
0 = Parameter Record 1
1 = Parameter Record 2
Rapid Start Range (decimal):
0 (default)
to 2^26-1 increments
Write command

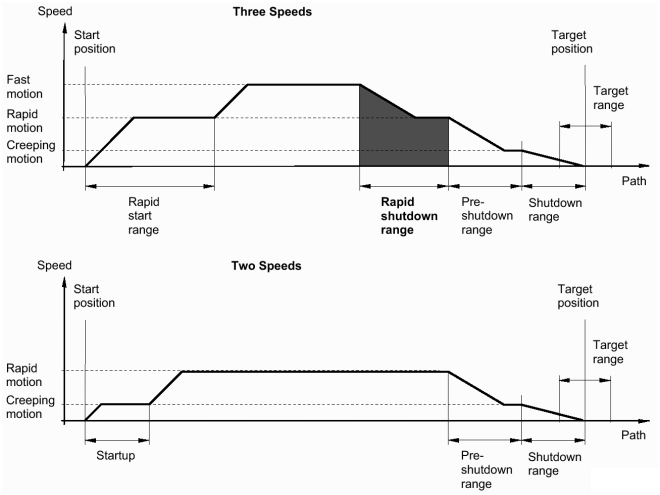
Format of the Read Rapid Start Range Command


MSB
Output Word 0
Output Word 1
LSB
15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0
0 1 PR 0 0 1 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
Parameter Record:
0 = Parameter Record 1
1 = Parameter Record 2
Read command

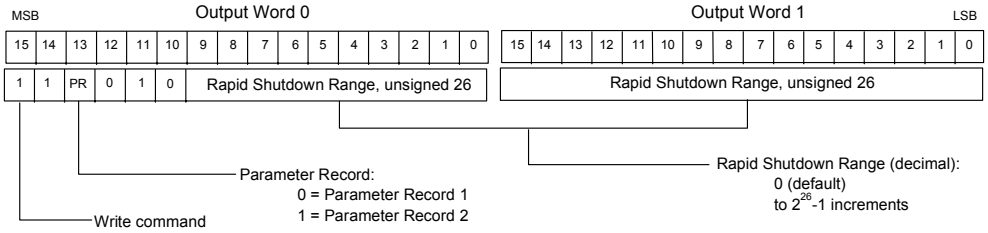
Read Rapid Start Range Reply from the Module


MSB
Input Word 0
Input Word 1
LSB
15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0
ST 1 PR 0 0 1
Rapid Start Range, unsigned 26 bits
Rapid Start Range, unsigned 26 bits
Status, error = 1

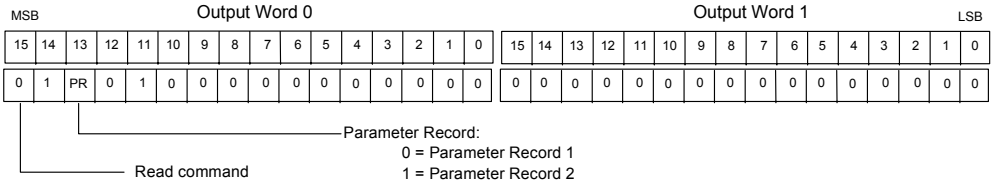
Define/Read Rapid Shutdown Range Command



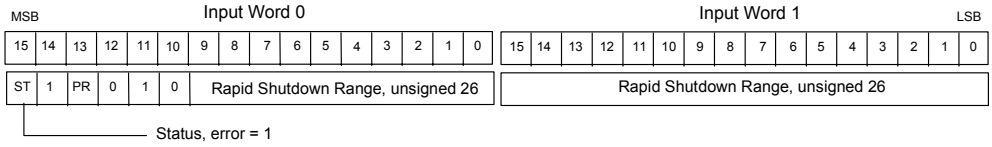
Format of the Define Rapid Shutdown Range Command


MSB
Output Word 0
Output Word 1
LSB
15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0
15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0
1 1 PR 0 1 0 Rapid Shutdown Range, unsigned 26
Rapid Shutdown Range, unsigned 26
Parameter Record:
0 = Parameter Record 1
1 = Parameter Record 2
Rapid Shutdown Range (decimal):
0 (default)
to 2^26-1 increments
Write command

Format of the Read Rapid Shutdown Range Command

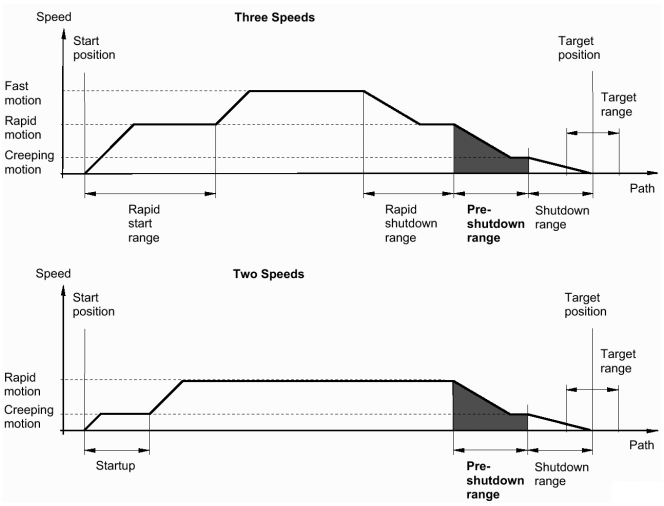

MSB
Output Word 0
Output Word 1
LSB
15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0
15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0
0 1 PR 0 1 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
Parameter Record:
0 = Parameter Record 1
1 = Parameter Record 2
Read command

Read Rapid Shutdown Range Reply from the Module

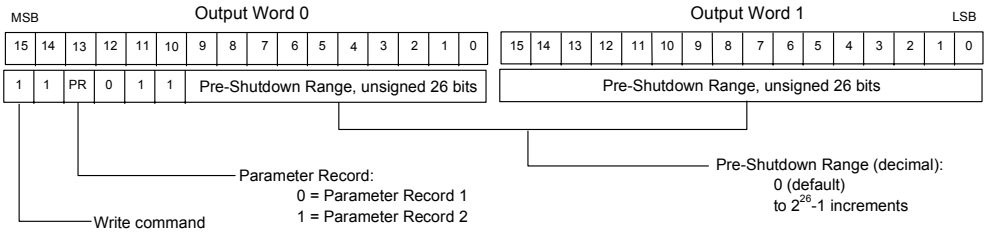

MSB
Input Word 0
Input Word 1
LSB
15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0
15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0
ST 1 PR 0 1 0 Rapid Shutdown Range, unsigned 26
Rapid Shutdown Range, unsigned 26
Status, error = 1

.

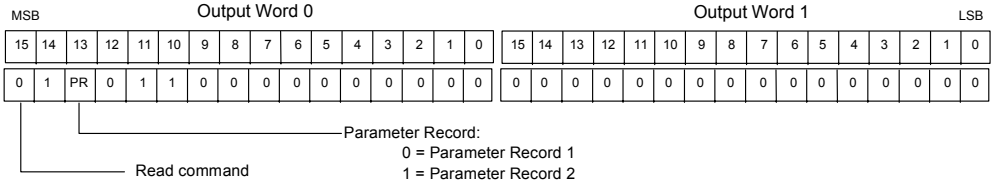
Define/Read Pre-Shutdown Range Command



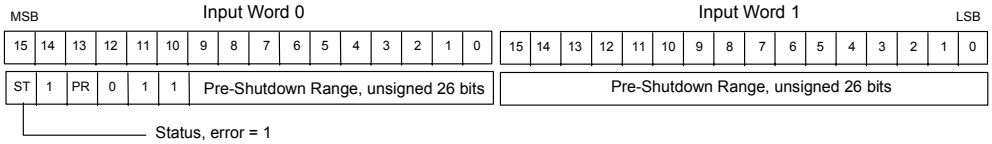
Format of the Define Pre-Shutdown Range Command


MSB
Output Word 0
Output Word 1
LSB
15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0
1 1 PR 0 1 1 Pre-Shutdown Range, unsigned 26 bits
Pre-Shutdown Range, unsigned 26 bits
Pre-Shutdown Range (decimal):
0 (default)
to 2^26-1 increments
Parameter Record:
0 = Parameter Record 1
1 = Parameter Record 2
Write command

Format of the Read Pre-Shutdown Range Command

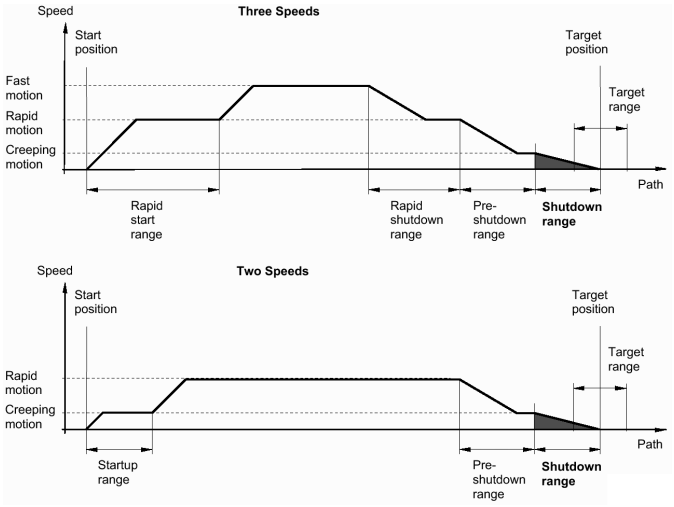

MSB
Output Word 0
Output Word 1
LSB
15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0
0 1 PR 0 1 1 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
Parameter Record:
0 = Parameter Record 1
1 = Parameter Record 2
Read command

Read Pre-Shutdown Range Reply from the Module

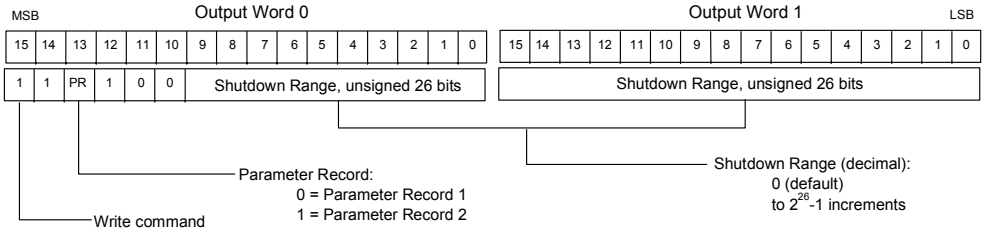

MSB
Input Word 0
Input Word 1
LSB
15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0
ST 1 PR 0 1 1 Pre-Shutdown Range, unsigned 26 bits
Pre-Shutdown Range, unsigned 26 bits
Status, error = 1

.

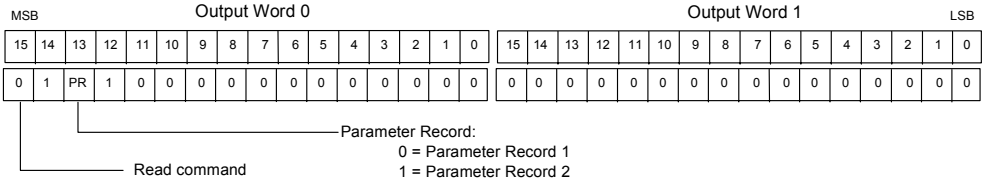
Define/Read Shutdown Range Command



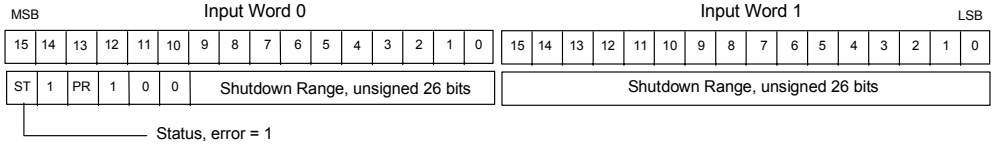
Format of the Define Shutdown Range Command


MSB
Output Word 0
Output Word 1
LSB
15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0
1 1 PR 1 0 0 Shutdown Range, unsigned 26 bits
Shutdown Range, unsigned 26 bits
Parameter Record:
0 = Parameter Record 1
1 = Parameter Record 2
Write command
Shutdown Range (decimal):
0 (default)
to 2^26-1 increments

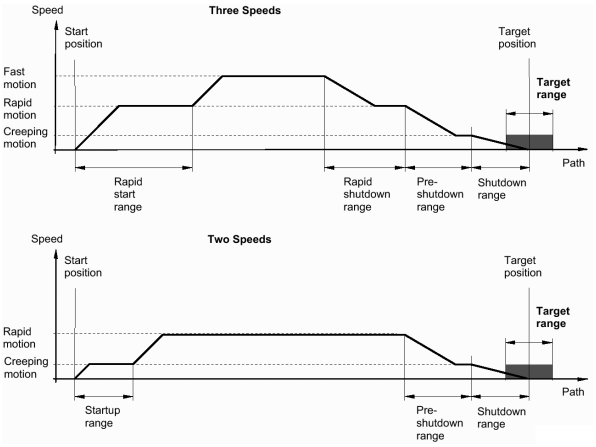
Format of the Read Shutdown Range Command


MSB
Output Word 0
Output Word 1
LSB
15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0
0 1 PR 1 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
Parameter Record:
0 = Parameter Record 1
1 = Parameter Record 2
Read command

Read Shutdown Range Reply from the Module

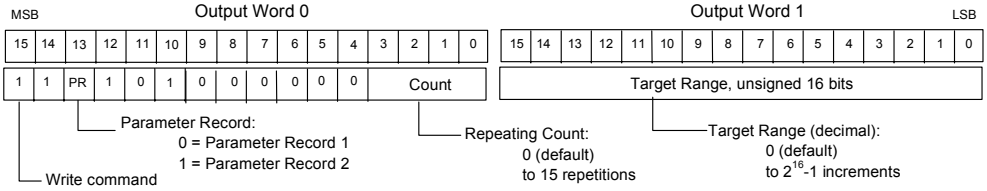

MSB
Input Word 0
Input Word 1
LSB
15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0
ST 1 PR 1 0 0 Shutdown Range, unsigned 26 bits
Shutdown Range, unsigned 26 bits
Status, error = 1

Define/Read Target Range Command

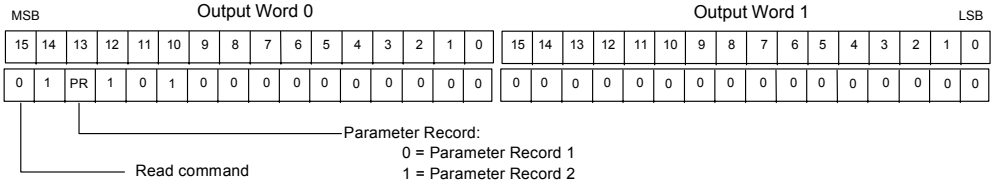


If the target range is not reached, the module can automatically start a new approach to the target position. Before a new approach can be made to the target position, looping must be activated. The repetition counter specifies the maximum number of repetitions. Up to 15 repetitions are possible.

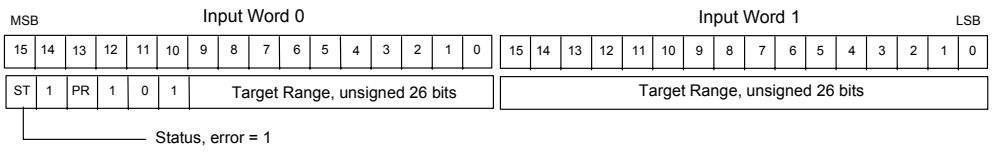
Format of the Define Target Range Command


MSB
Output Word 0
Output Word 1
LSB
15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0
15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0
1 1 PR 1 0 1 0 0 0 0 0 0 Count
Target Range, unsigned 16 bits
Parameter Record:
0 = Parameter Record 1
1 = Parameter Record 2
Write command
Repeating Count:
0 (default)
to 15 repetitions
Target Range (decimal):
0 (default)
to 2^16-1 increments

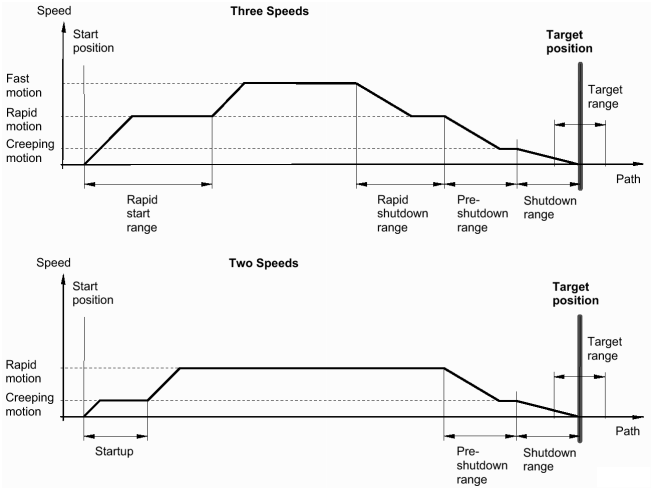
Format of the Read Target Range Command


MSB
Output Word 0
Output Word 1
LSB
15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0
15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0
0 1 PR 1 0 1 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
Parameter Record:
0 = Parameter Record 1
1 = Parameter Record 2
Read command

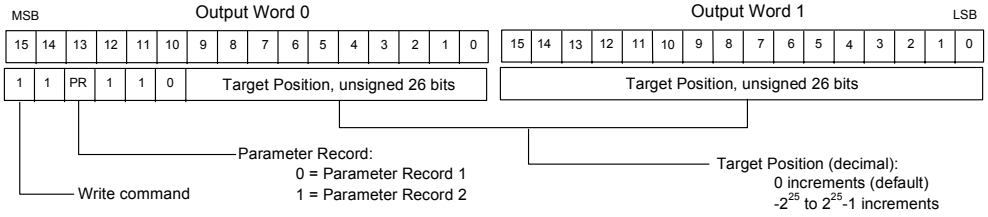
Read Target Range Reply from the Module


MSB
Input Word 0
Input Word 1
LSB
15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0
15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0
ST 1 PR 1 0 1 Target Range, unsigned 26 bits
Target Range, unsigned 26 bits
Status, error = 1

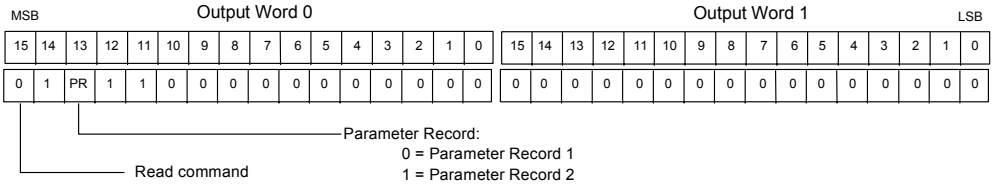
Define/Read Target Position



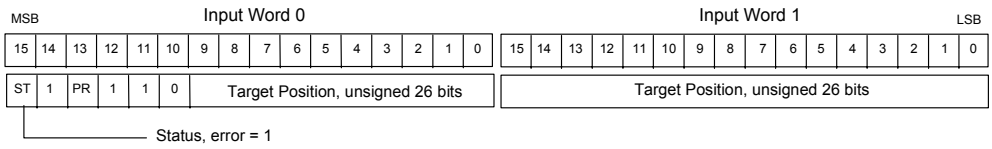
Format of the Define Target Position Command


MSB
Output Word 0
Output Word 1
LSB
15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0
1 1 PR 1 1 0
Target Position, unsigned 26 bits
Target Position, unsigned 26 bits
Parameter Record:
0 = Parameter Record 1
1 = Parameter Record 2
Write command
Target Position (decimal):
0 increments (default)
-2^25 to 2^25-1 increments

Format of the Read Target Position Command


MSB
Output Word 0
Output Word 1
LSB
15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0
0 1 PR 1 1 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
Parameter Record:
0 = Parameter Record 1
1 = Parameter Record 2
Read command

Read Target Position Reply from the Module

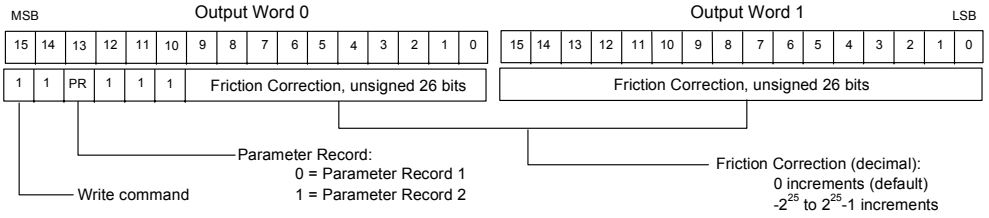

MSB
Input Word 0
Input Word 1
LSB
15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0
ST 1 PR 1 1 0
Target Position, unsigned 26 bits
Target Position, unsigned 26 bits
Status, error = 1

Define/Read Friction Correction Value Command

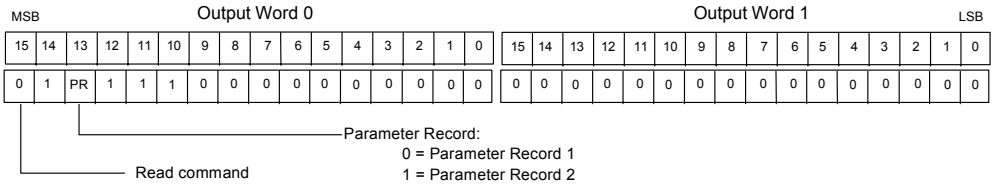
In positioning with switched axes, positioning accuracy depends on the stability of the system parameters. Temperature and wear can affect positioning accuracy.

The *Define Friction Correction Value* command can be used to program a correction value for each parameter record. Actual use of the correction value, once configured, is activated using the positioning commands, as described in the next chapter.

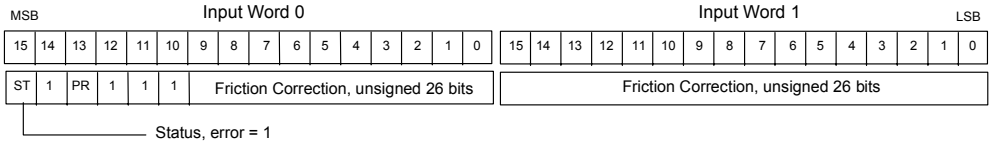
Format of the Define Friction Value Command


MSB
Output Word 0
Output Word 1
LSB
15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0
15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0
1 1 PR 1 1 1 Friction Correction, unsigned 26 bits
Friction Correction, unsigned 26 bits
Parameter Record:
0 = Parameter Record 1
1 = Parameter Record 2
Write command
Friction Correction (decimal):
0 increments (default)
-2^25 to 2^25-1 increments

Format of the Read Friction Value Command


MSB
Output Word 0
Output Word 1
LSB
15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0
15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0
0 1 PR 1 1 1 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
Parameter Record:
0 = Parameter Record 1
1 = Parameter Record 2
Read command

Read Friction Value Reply from the Module


MSB
Input Word 0
Input Word 1
LSB
15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0
15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0
ST 1 PR 1 1 1 Friction Correction, unsigned 26 bits
Friction Correction, unsigned 26 bits
Status, error = 1

Chapter 6 Positioning Commands

After completing the setup operations described in the previous chapters, the host can use the Read/Control Positioning commands:

The three Read commands request position, status, or reference mark data.

The three Control Positioning commands all perform the same control functions. They also request the module to return either position, status, or reference mark data. The choice of which Control Positioning command to use depends on what type of input data the host wants the module to return.

- *Read Position*:
  - reads the current position of the drive.
- *Control Positioning and Read Position*:
  - controls the module outputs as configured, and
  - reads the current position of the drive.
- *Read Status*:
  - reads the current states of the module's inputs and outputs, the status of the positioning process, and error codes.
- *Control Positioning and Read Status*:
  - controls the module outputs as configured, and
  - reads the current states of the module's inputs and outputs, the status of the positioning process, and error codes.
- *Read Reference Mark*
  - reads the reference mark position.
- *Control Positioning and Read Reference Mark*
  - controls the module outputs as configured, and
  - reads the reference mark position.

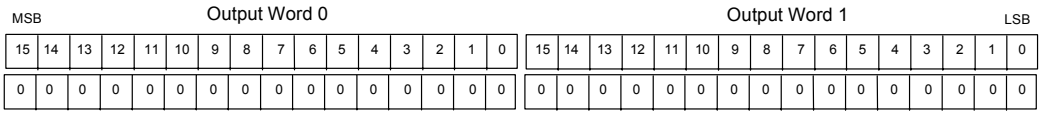
This chapter also includes examples of using the Control Positioning commands for Looping, Homing, Position Monitoring, and Backlash Compensation.

Read Position Command

Use the *Read Position* command to read the current position of the drive without controlling positioning.

If you want to read the position and control positioning using one output command, use the *Control Positioning and Read Position* command instead.

Format of the Read Position Command

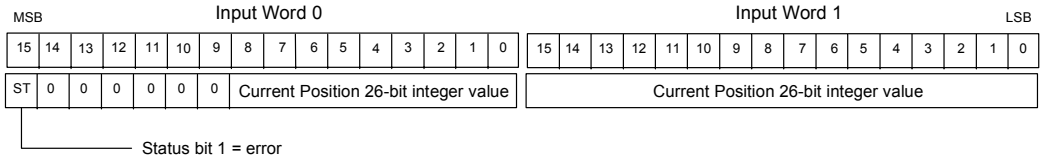


Position Data Returned by the Module

After receiving a *Read Position* command, the module returns the current position to the NIU in its input data words. It is a value in two's complement format, in the range:

-2^{25} to $+(2^{25}-1)$

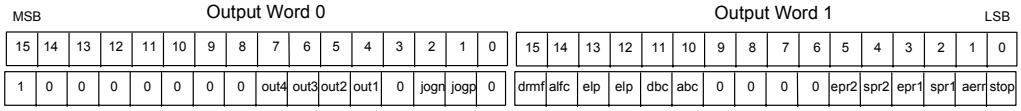
If an error has occurred, the status bit is set to 1. If the host needs to read additional status information, a *Read Status* command can be used.


MSB
Input Word 0
15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0
ST 0 0 0 0 0 0 Current Position 26-bit integer value
Status bit 1 = error
Input Word 1
LSB
15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0
Current Position 26-bit integer value

Control Positioning and Read Position Command

Use this command to control positioning and read the position with one output command. The data returned by this command is the same as for the *Read Position* command. If an error occurs during positioning, the status bit is set to 1. A *Read Status* command can be used to obtain more information about the error. If a function is interrupted by an error, a new action can only be started after the error has been acknowledged by setting bit 1 of output word 1 (see below) of the positioning command.

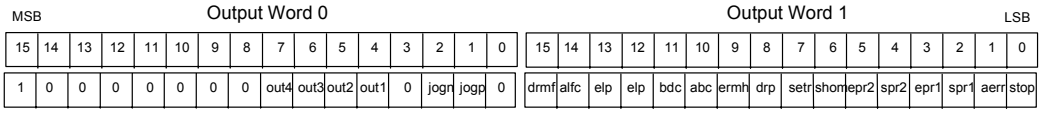
Control Positioning and Read Position Command, Absolute Encoder Module


MSB
Output Word 0
Output Word 1
LSB
15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0
15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0
1 0 0 0 0 0 0 0 out4 out3 out2 out1 0 jogn jogp 0
drmf alfc elp elp dbc abc 0 0 0 0 epr2 spr2 epr1 spr1 aerr stop

Some bits are evaluated when set to 1; others when they change from 0 to 1.

Bit	Active	Description		Notes
Output Word 0				
9, 8			Reserved	
7	set to 1	OUT4	Output 4	These outputs are only used if Version 5 output control has been set up using the *Configure Initiators and Switching Outputs* command, as described in chapter 4.
6	set to 1	OUT3	Output 3	
5	set to 1	OUT2	Output 2	
4	set to 1	OUT1	Output 1	
3			Reserved	
2	set to 1	JOGN	Jog in negative direction	Drive runs at creeping speed. Jogging has the highest priority, but does not stop other processes (positioning, homing, looping).
1	set to 1	JOGP	Jog in positive direction	
0			Reserved	
Output Word 1				
15	0→ 1	DRMF	Delete reference mark flag	Reference Mark flag is input word 1 bit 15 of *Read Status* reply.
14	set to 1	ALFC	Activate lubrication and friction compensation	
13			Reserved	
12	set to 1	ELP	Enable looping. See the example later in this chapter.	
11	set to 1	DBC	Define starting direction of target position during active backlash compensation or looping	0: positive direction; 1: negative direction. For active backlash compensation or looping
10	set to 1	ABC	Activate backlash compensation. See the example later in this chapter.	
9 - 6			Reserved	
5	set to 1	EPR2	Start positioning with parameter record 2 using digital inputs (initiators)	
4	0→ 1	SPR2	Start positioning with parameter record 2	
3	set to 1	EPR1	Start positioning with parameter record 1 using digital inputs (initiators)	
2	0→ 1	SPR1	Start positioning with parameter record 1	
1	0→ 1	AERR	Acknowledge error	
0	set to 1	STOP	Positioning stopped immediately	The command being executed is cancelled. A new positioning process cannot be started until the stop bit has been reset.

Control Positioning and Read Position, Incremental Encoder Module


MSB
Output Word 0
15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0
1 0 0 0 0 0 0 0 out4 out3 out2 out1 0 jogn jogp 0
Output Word 1
LSB
15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0
drmf alfc elp elp bdc abc ermh drp setr shom epr2 spr2 epr1 spr1 aerr stop

Some bits are evaluated when set to 1; others when they change from 0 to 1.

Bit	Active		Description	Notes
Output Word 0				
9, 8			Reserved	
7	set to 1	OUT4	Output 4	These outputs are only used if Version 5 output control has been set up using the *Configure Initiators and Switching Outputs* command, as described in chapter 4.
6	set to 1	OUT3	Output 3	
5	set to 1	OUT2	Output 2	
4	set to 1	OUT1	Output 1	
3			Reserved	
2	set to 1	JOGN	Jog in negative direction	Drive runs at creeping speed. Jogging has the highest priority, but does not stop other processes (positioning, homing, looping).
1	set to 1	JOGP	Jog in positive direction	
0			Reserved	
Output Word 1				
15	0→ 1	DRMF	Delete reference mark flag	Reference Mark flag is input word 1 bit 15 of *Read Status* reply.
14	set to 1	ALFC	Activate lubrication and friction compensation	
13			Reserved	
12	set to 1	ELP	Enable looping. See the example later in this chapter.	
11	set to 1	DBC	Define starting direction of target position during active backlash compensation or looping	0: positive direction; 1: negative direction. For active backlash compensation or looping
10	set to 1	ABC	Activate backlash compensation. See the example later in this chapter.	
9	set to 1	ERMH	Enable rapid motion for homing	The start range is defined using parameter record 1
8	set to 1	DRP	Define direction from which reference point is started	0: positive direction 1: negative direction
7	0→ 1	SETR	Set reference point	
6	0→ 1	SHOM	Start homing. See the example later in this chapter.	
5	set to 1	EPR2	Start positioning process with parameter record 2 using digital inputs (initiators)	
4	0→ 1	SPR2	Start positioning with parameter record 2	
3	set to 1	EPR1	Start positioning with parameter record 1 using digital inputs (initiators)	
2	0→ 1	SPR1	Start positioning with parameter record 1	
1	0→ 1	AERR	Acknowledge error	
0	set to 1	STOP	Positioning stopped immediately	The command currently being executed is cancelled. A new positioning process cannot be started until the stop bit has been reset.

Read Status Command

Use the *Read Status* command to read the current states of the inputs and outputs, the error status, the positioning status, and an error code if the status bit is set.

If you want to read the status information and control positioning with one output command, use the *Control Positioning and Read Status* command instead.

Positioning Status Information

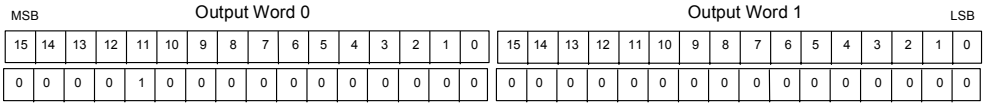
When status is read after positioning, the status words indicate the result of the positioning process. If the target range was reached, bit 2 of output word 1 (positioning process with parameter record 1 was completed successfully) or bit 4 of output word 1 (positioning with parameter record 2 process was completed successfully) is set in the status word.

If the target range was not reached, bit 15 (error) is set in the status word, and error code 17, "target range could not be reached" is returned in word 1.

If the parameters for monitoring the drive stop are set too low, then effects such as vibrations on the axis may mean that no stop is detected. In that case, the positioning process is not completed and can only be interrupted by setting bit 0 of output word 0 ("Stop") in a *Control Positioning* command to 1.

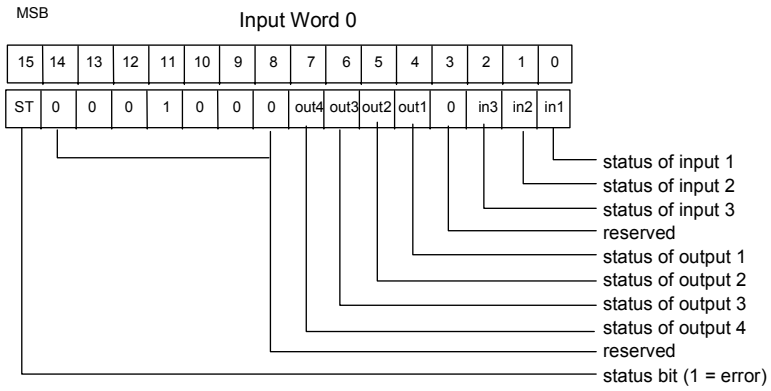
When drive stop monitoring is not active, the stop bit is constantly set.

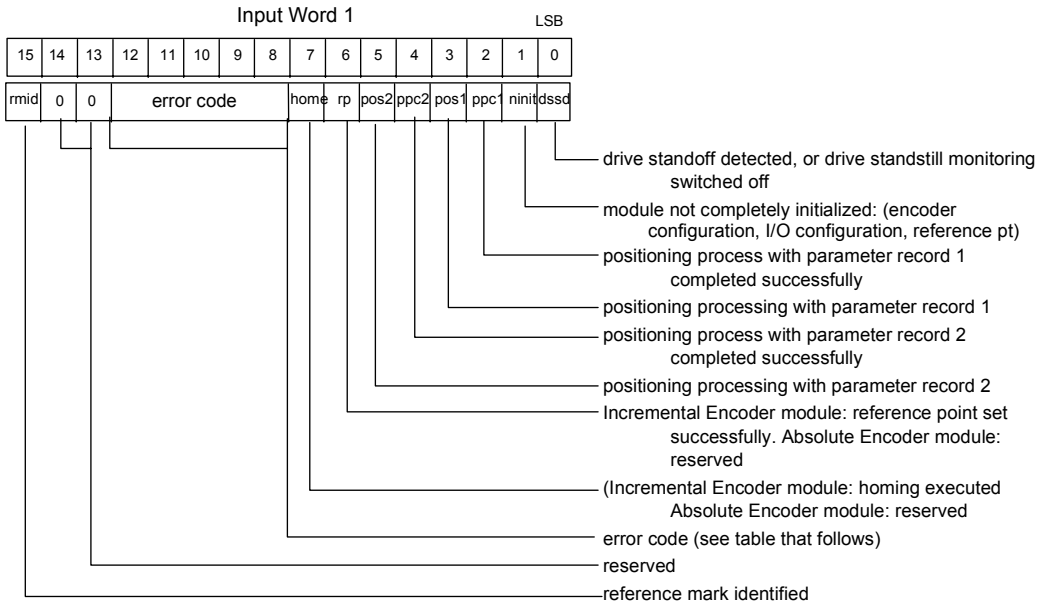
Format of the Read Status Command



Status Data Returned by the Module

The positioning module returns the current status to the NIU in its input data words. If an error has occurred, the status bit is set to 1. The type of error that occurred is indicated by the error code.


MSB
Input Word 0
15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0
ST 0 0 0 1 0 0 0 out4 out3 out2 out1 0 in3 in2 in1
status of input 1
status of input 2
status of input 3
reserved
status of output 1
status of output 2
status of output 3
status of output 4
reserved
status bit (1 = error)


Input Word 1
LSB
15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0
rmid 0 0 error code home rp pos2 ppc2 pos1 ppc1 ninit dssd
drive standoff detected, or drive standstill monitoring switched off
module not completely initialized: (encoder configuration, I/O configuration, reference pt)
positioning process with parameter record 1 completed successfully
positioning processing with parameter record 1
positioning process with parameter record 2 completed successfully
positioning processing with parameter record 2
Incremental Encoder module: reference point set successfully. Absolute Encoder module: reserved
(Incremental Encoder module: homing executed Absolute Encoder module: reserved
error code (see table that follows)
reserved
reference mark identified

Error Codes Returned by the Status Command

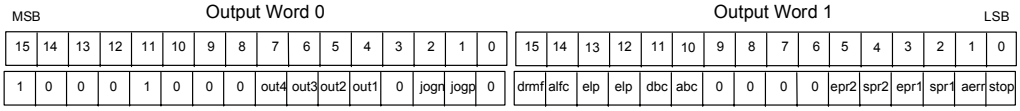
The table below lists error codes that may be returned by a positioning module in bits 12 to 8 of input word 1:

Error Code Bits 12...8 bin	Error Code Bits 12...8 dec	Meaning	Comment/Cause and Notes on Error Correction
0 0000	0	No error occurred	
0 0001	1	Module is in Operator Hand Panel mode	Control by command not possible in this mode.
0 0010	2	Overload or short-circuit of the output driver	This error also triggers a module error message. Remove short-circuit or overload.
0 0011	3	Malfunction of the encoder supply	This error also triggers a module error message. Cause: no encoder supply or short-circuit. Connect encoder supply or remove the short- circuit
0 0100	4	Invalid encoder configuration	Check encoder configuration.
0 0101	5	A parity error has occurred (only IC220MDD841).	Connection to the sensor is defective or sensor is configured incorrectly. Check connection and configuration.
0 0110	6	The initiator or switching output configuration is invalid.	Check configuration.
0 0111	7	No reference point set.	Start homing or set reference point.
0 1000	8	Invalid control command.	Check control command.
0 1001	9	Position to be approached is out of the permissible range or is not defined.	Check specification.
0 1010	10	Function cannot be executed, as the software limit switches would be overrun	Change software limit switches.
0 1011	11	Motor does not rotate or rotates in the wrong direction.	
0 1100	12	No reference point found.	Start homing in another direction.
0 1101	13	The distance to the target position is less than the sum of the shutdown and start range.	Enable looping.
0 1110	14	Drive stop detected.	
0 1111	15	Software limit switch reached.	
1 0000	16	Hardware limit switch reached.	
1 0001	17	Target range could not be reached.	Check parameters of the shutdown and target range.
1 0010	18	Counter overflow	The current position value is greater than the area of representation. For IC220MDD842: Define another increment evaluation. For IC220MDD841: Define another offset.
1 0011	19	Invalid action	An attempt was made to start an invalid action. Example: A control command is still being executed. Check action.
1 0100	20	Reset	
1 0101	21	Invalid system configuration.	Check system configuration.

Control Positioning and Read Status Command

Use this command to both control positioning and read the status. The data returned by this command is the same as for the *Read Status* command. If an error occurs during positioning, the status bit is set to 1. The status bits provide information about the error. When a function is interrupted by an error message, a new action can only be started after the error has been acknowledged by setting bit 1 of output word 1 of the positioning command.

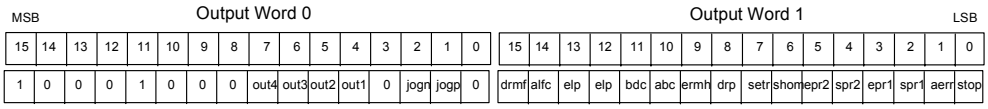
Control Positioning and Read Status Command, Absolute Encoder Module


MSB
Output Word 0
Output Word 1
LSB
15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0
15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0
1 0 0 0 1 0 0 0 out4 out3 out2 out1 0 jogn jogp 0
drmf alfc elp elp dbc abc 0 0 0 0 epr2 spr2 epr1 spr1 aerr stop

Some bits are evaluated when set to 1; others when they change from 0 to 1.

Bit	Active		Description	Notes
Output Word 0				
9, 8			Reserved	
7	set to 1	OUT4	Output 4	These outputs are only used if Version 5 output control has been set up using the *Configure Initiators and Switching Outputs* command, as described in chapter 4.
6	set to 1	OUT3	Output 3	
5	set to 1	OUT2	Output 2	
4	set to 1	OUT1	Output 1	
3			Reserved	
2	set to 1	JOGN	Jog in negative direction	Drive runs at creeping speed. Jogging has the highest priority, but does not stop other processes (positioning, homing, looping).
1	set to 1	JOGP	Jog in positive direction	
0			Reserved	
Output Word 1				
15	0→ 1	DRMF	Delete reference mark flag	Reference Mark flag is input word 1 bit 15 of *Read Status* reply.
14	set to 1	ALFC	Activate lubrication and friction compensation	
13			Reserved	
12	set to 1	ELP	Enable looping. See the example later in this chapter.	
11	set to 1	DBC	Define starting direction of target position during active backlash compensation or looping	0: positive direction; 1: negative direction. For active backlash compensation or looping
10	set to 1	ABC	Activate backlash compensation. See the example later in this chapter.	
9 - 6			Reserved	
5	set to 1	EPR2	Start positioning with parameter record 2 using digital inputs (initiators)	
4	0→ 1	SPR2	Start positioning with parameter record 2	
3	set to 1	EPR1	Start positioning with parameter record 1 using digital inputs (initiators)	
2	0→ 1	SPR1	Start positioning with parameter record 1	
1	0→ 1	AERR	Acknowledge error	
0	set to 1	STOP	Positioning stops immediately	The command being executed is cancelled. A new positioning process cannot be started until the stop bit has been reset.

Control Positioning and Read Status, Incremental Encoder Module


MSB
Output Word 0
Output Word 1
LSB
15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0
15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0
1 0 0 0 1 0 0 0 out4 out3 out2 out1 0 jogn jogp 0
drmf alfc elp elp bdc abc ermh drp setr shom epr2 spr2 epr1 spr1 aerr stop

Some bits are evaluated when set to 1; others when they change from 0 to 1.

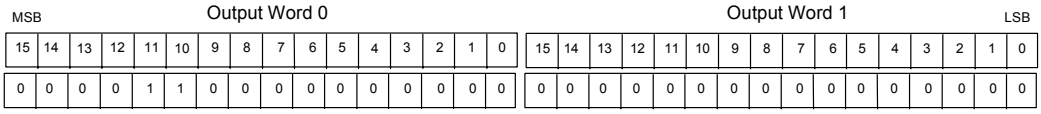
Bit	Active		Description	Notes
Output Word 0				
9, 8			Reserved	
7	set to 1	OUT4	Output 4	These outputs are only used if Version 5 output control has been set up using the *Configure Initiators and Switching Outputs* command, as described in chapter 4.
6	set to 1	OUT3	Output 3	
5	set to 1	OUT2	Output 2	
4	set to 1	OUT1	Output 1	
3			Reserved	
2	set to 1	JOGN	Jog in negative direction	Drive runs at creeping speed. Jogging has the highest priority, but does not stop other processes (positioning, homing, looping).
1	set to 1	JOGP	Jog in positive direction	
0			Reserved	
Output Word 1				
15	0→ 1	DRMF	Delete reference mark flag	Reference Mark flag is input word 1 bit 15 of *Read Status* reply.
14	set to 1	ALFC	Activate lubrication and friction compensation	
13			Reserved	
12	set to 1	ELP	Enable looping. See the example later in this chapter.	
11	set to 1	DBC	Define starting direction of target position during active backlash compensation or looping	0: positive direction; 1: negative direction. For active backlash compensation or looping
10	set to 1	ABC	Activate backlash compensation. See the example later in this chapter.	
9	set to 1	ERMH	Enable rapid motion for homing	The start range is defined using parameter record 1
8	set to 1	DRP	Define direction from which reference point is started	0: positive direction 1: negative direction
7	0→ 1	SETR	Set reference point	
6	0→ 1	SHOM	Start homing. See the example later in this chapter.	
5	set to 1	EPR2	Start positioning process with parameter record 2 using digital inputs (initiators)	
4	0→ 1	SPR2	Start positioning with parameter record 2	
3	set to 1	EPR1	Start positioning with parameter record 1 using digital inputs (initiators)	
2	0→ 1	SPR1	Start positioning with parameter record 1	
1	0→ 1	AERR	Acknowledge error	
0	set to 1	STOP	Positioning stopped immediately	The command currently being executed is cancelled. A new positioning process cannot be started until the stop bit has been reset.

Read Reference Mark Command

Use the *Read Reference Mark* command to read the reference mark position for the module without controlling positioning.

If you want to read the reference mark and control positioning information with one output command, use the *Control Positioning and Read Reference Mark* command instead.

Format of the Read the Reference Mark Command

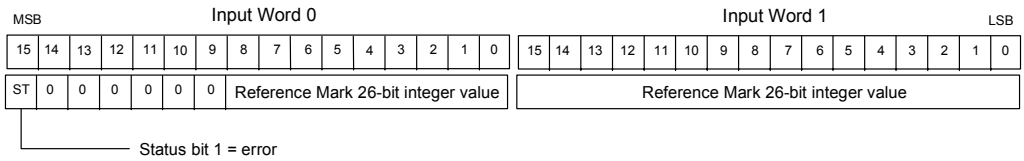


Reference Mark Data Returned by the Module

The positioning module returns the reference mark position to the NIU in its input data words. The reference mark is a value in the range:

-2^{25} to $+(2^{25}-1)$

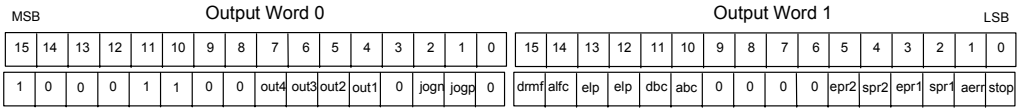
If an error occurs, the status bit is set to 1. If the *Read Status* command is then sent, the module will return more information about the type of error that occurred.


MSB
Input Word 0
15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0
ST 0 0 0 0 0 0 Reference Mark 26-bit integer value
Status bit 1 = error
Input Word 1
LSB
15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0
Reference Mark 26-bit integer value

Control Positioning and Read Reference Mark Command

Use this command to both control positioning and read the reference mark position using one output command. The data returned by this command is the same as for the *Read Reference Mark* command. If an error occurs during positioning, the status bit is set to 1. Use a *Read Status* command to get information about the error. When a function is interrupted by an error message, a new action can only be started after the error has been acknowledged by setting bit 1 of output word 1 (see below) of the positioning command.

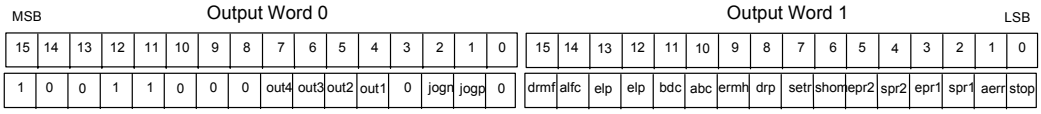
Control Positioning and Read Reference Mark Absolute Encoder Module


MSB
Output Word 0
Output Word 1
LSB
15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0
15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0
1 0 0 0 1 1 0 0 out4 out3 out2 out1 0 jogn jogp 0
drmf alfc elp elp dbc abc 0 0 0 0 epr2 spr2 epr1 spr1 aerr stop

Some bits are evaluated when set to 1; others when they change from 0 to 1.

Bit	Active		Description	Notes
Output Word 0				
9, 8			Reserved	
7	set to 1	OUT4	Output 4	These outputs are only used if Version 5 output control has been set up using the *Configure Initiators and Switching Outputs* command, as described in chapter 4.
6	set to 1	OUT3	Output 3	
5	set to 1	OUT2	Output 2	
4	set to 1	OUT1	Output 1	
3			Reserved	
2	set to 1	JOGN	Jog in negative direction	Drive runs at creeping speed. Jogging has the highest priority, but does not stop other processes (positioning, homing, looping).
1	set to 1	JOGP	Jog in positive direction	
0			Reserved	
Output Word 1				
15	0→ 1	DRMF	Delete reference mark flag	Reference Mark flag is input word 1 bit 15 of *Read Status* reply.
14	set to 1	ALFC	Activate lubrication and friction compensation	
13			Reserved	
12	set to 1	ELP	Enable looping. See the example later in this chapter.	
11	set to 1	DBC	Define starting direction of target position during active backlash compensation or looping	0: positive direction; 1: negative direction. For active backlash compensation or looping
10	set to 1	ABC	Activate backlash compensation. See the example later in this chapter.	
9 - 6			Reserved	
5	set to 1	EPR2	Start positioning process with parameter record 2 using digital inputs (initiators)	
4	0→ 1	SPR2	Start positioning with parameter record 2	
3	set to 1	EPR1	Start positioning with parameter record 1 using digital inputs (initiators)	
2	0→ 1	SPR1	Start positioning with parameter record 1	
1	0→ 1	AERR	Acknowledge error	
0	set to 1	STOP	Positioning stopped immediately	The command being executed is cancelled. A new positioning process cannot be started until the stop bit has been reset.

Control Positioning and Read Reference Mark, Incremental Encoder Module


MSB
Output Word 0
15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0
1 0 0 1 1 0 0 0 out4 out3 out2 out1 0 jogn jogp 0
Output Word 1
LSB
15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0
drmf alfc elp elp bdc abc ermh drp setr shom epr2 spr2 epr1 spr1 aerr stop

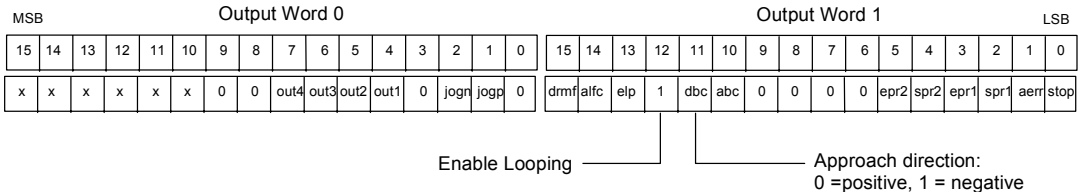
The rest of the bits contain the command information. Some bits are evaluated when set to 1; others when they change from 0 to 1.

Bit	Active		Description	Notes
Output Word 0				
9, 8			Reserved	
7	set to 1	OUT4	Output 4	These outputs are only used if Version 5 output control has been set up using the *Configure Initiators and Switching Outputs* command, as described in chapter 4.
6	set to 1	OUT3	Output 3	
5	set to 1	OUT2	Output 2	
4	set to 1	OUT1	Output 1	
3			Reserved	
2	set to 1	JOGN	Jog in negative direction	Drive runs at creeping speed. Jogging has the highest priority, but does not stop other processes (positioning, homing, looping).
1	set to 1	JOGP	Jog in positive direction	
0			Reserved	
Output Word 1				
15	0→ 1	DRMF	Delete reference mark flag	Reference Mark flag is input word 1 bit 15 of *Read Status* reply.
14	set to 1	ALFC	Activate lubrication and friction compensation.	
13			Reserved	
12	set to 1	ELP	Enable looping. See the example later in this chapter.	
11	set to 1	DBC	Define starting direction of target position during active backlash compensation or looping	0: positive direction; 1: negative direction. For active backlash compensation or looping
10	set to 1	ABC	Activate backlash compensation. See the example later in this chapter.	
9	set to 1	ERMH	Enable rapid motion for homing	The start range is defined using parameter record 1
8	set to 1	DRP	Define direction from which reference point is started	0: positive direction 1: negative direction
7	0→ 1	SETR	Set reference point	
6	0→ 1	SHOM	Start homing. See the example later in this chapter.	
5	set to 1	EPR2	Start positioning process with parameter record 2 using digital inputs (initiators)	
4	0→ 1	SPR2	Start positioning with parameter record 2	
3	set to 1	EPR1	Start positioning with parameter record 1 using digital inputs (initiators)	
2	0→ 1	SPR1	Start positioning with parameter record 1	
1	0→ 1	AERR	Acknowledge error	
0	set to 1	STOP	Positioning stopped immediately	The command currently being executed is cancelled. A new positioning process cannot be started until the stop bit has been reset.

Positioning Command Example: Looping

If the difference between the start and target position is less than the sum of the start range and shutdown range, the target position cannot be approached directly. If looping has been enabled, then after the drive has stopped, the module will automatically exit the range and approach the position again.

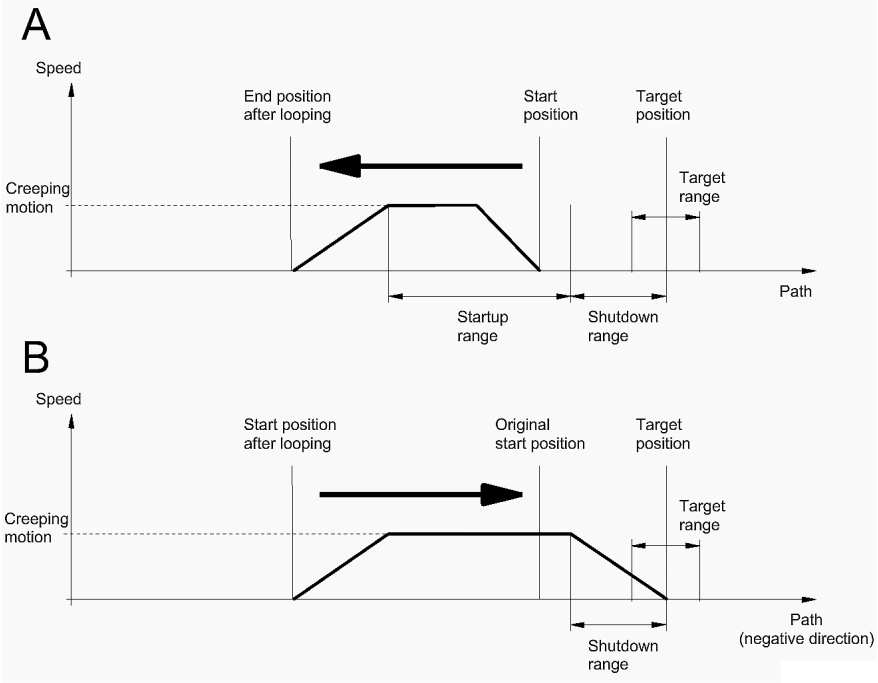
To enable or disable Looping, use bit 12 of output word 1 in one of the *Control Positioning* commands. To specify the direction of the loop, use bit 11 (Approach direction). For example:


MSB
Output Word 0
15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0
x x x x x x 0 0 out4 out3 out2 out1 0 jogn jogp 0
Output Word 1
LSB
15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0
drmf alfc elp 1 dbc abc 0 0 0 0 epr2 spr2 epr1 spr1 aerr stop
Enable Looping
Approach direction:
0 =positive, 1 = negative

The traversing direction on exiting the target range is the opposite of the approach direction specified in bit 11.

Example of Looping

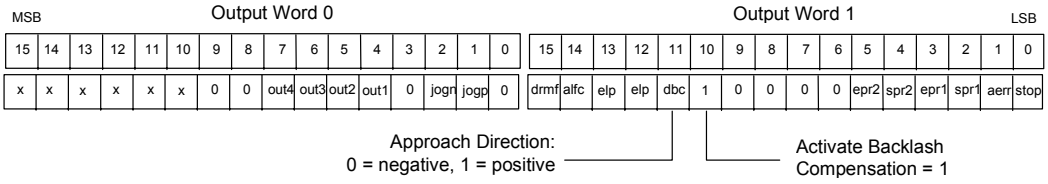
In diagram A below, the end position of one operation is the start of the next operation. The new start position is within the sum of the start range and shutdown range, so it cannot be approached directly. The drive must be moved out of the start/shutdown range using looping. The end point of this looping is the start position for approaching the target position (diagram B).



Positioning Command Example: Backlash Compensation

Drive systems usually have clearance, called backlash. When the direction changes, backlash causes a motor rotation without changing the drive position. If the position encoder is linked with the motor axis, backlash reduces positioning accuracy.

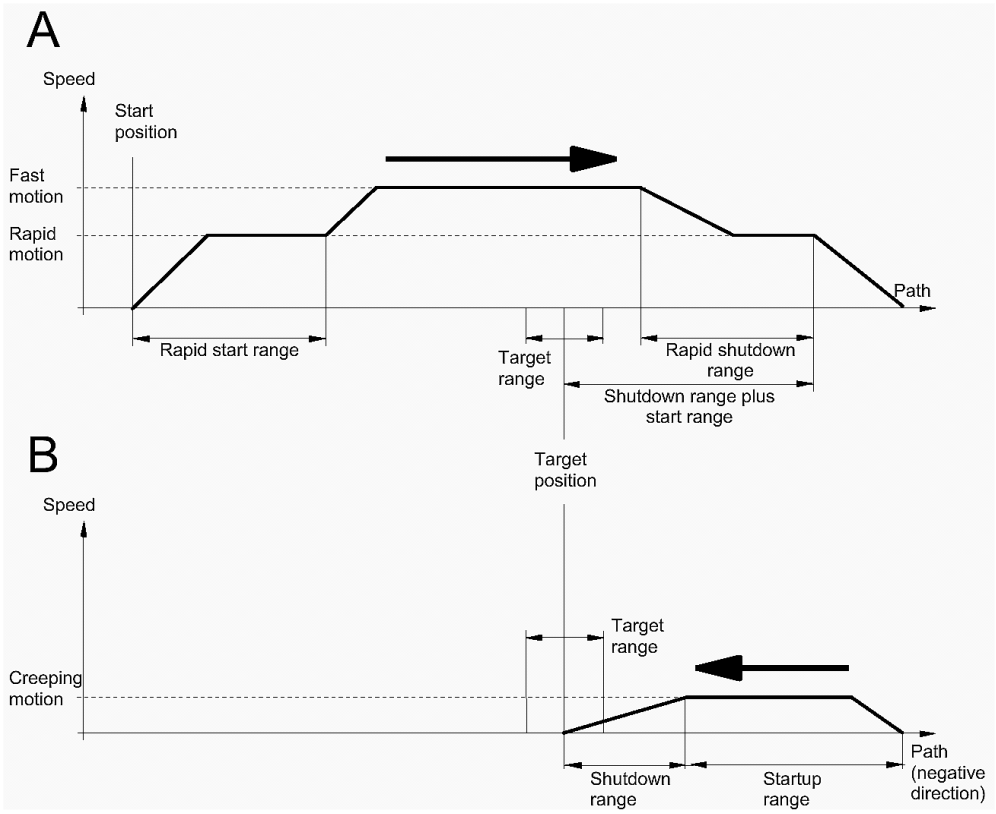
Backlash compensation can be activated and deactivated using bit 10 (Activate backlash compensation) of output word 1of one of the *Control Positioning* commands. The approach direction of the position is specified using bit 11.


MSB
Output Word 0
Output Word 1
LSB
15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0
x x x x x x 0 0 out4 out3 out2 out1 0 jogn jogp 0
15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0
drmf alfc elp elp dbc 1 0 0 0 0 epr2 spr2 epr1 spr1 aerr stop
Approach Direction:
0 = negative, 1 = positive
Activate Backlash
Compensation = 1

When backlash compensation is active, the module monitors whether the software limit switches are exceeded during positioning. If so, the position is not approached. The module generates error message 10: "Backlash function cannot be executed, because this would exceed software limit switches" in the *Read Status* input words.

Example: Approaching a Position with Backlash Compensation

In diagram A below, if the specified approach direction is positive and the position is approached in a negative direction, then with backlash compensation activated, the target position will first be overrun. When the rapid shutdown range is reached, the drive is stopped and comes to a stop outside the "shutdown range plus start range" range. In diagram B, because the target position was overrun, the drive changes direction and approaches the target position again in a positive direction.



Positioning Command Example: Using a Positioning Module for Position DetectionOnly

A VersaPoint positioning module can be used to simply determine the position of a drive, without controlling the positioning operation. In this type of application, the encoder is connected to the encoder interface, and the module's inputs and outputs are not used for positioning. Therefore, the modules inputs and outputs can be used for other digital input and output signals.

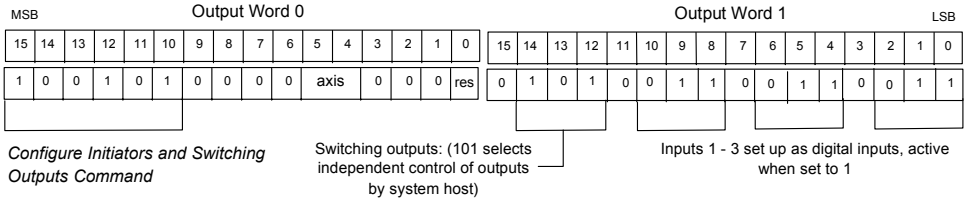
Configuring Independent Digital Inputs and Outputs

Digital input devices used as module inputs are configured using the three sets of Initiator bits in the *Configure Initiators and Switching Outputs* command. Such a digital input can be considered active when the input signal is set to 0 or 1.

Word 1 Bits 2-0	***Switch Active When:***	***Initiator 1***
011	Set to 1	Digital input
111	Set to 0	
Word 1 Bits 6-4	***Switch Active When***	***Initiator 2***
011	Set to 1	Digital input
111	Set to 0	
Word 1 Bits 10-8	***Switch Active When***	***Initiator 3***
011	Set to 1	Digital input
111	Set to 0	

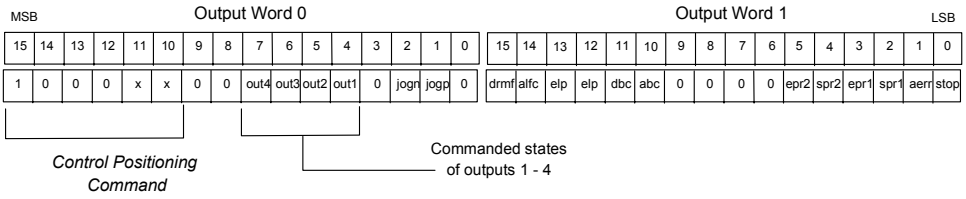
To set up the module to control independent outputs, select Output Version 5 (independent output control) using bits 14 to 12 of output word 1of the *Configure Initiators and Switching Outputs* command.

The following example shows the bits of the *Configure Initiators and Switching Outputs* command set up for Version 5 outputs, and for all three inputs set up as digital inputs that are active when set to 1:


MSB
Output Word 0
15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0
1 0 0 1 0 1 0 0 0 0 axis 0 0 0 res
Output Word 1
LSB
15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0
0 1 0 1 0 0 1 1 0 0 1 1 0 0 1 1
Configure Initiators and Switching Outputs Command
Switching outputs: (101 selects independent control of outputs by system host)
Inputs 1 - 3 set up as digital inputs, active when set to 1

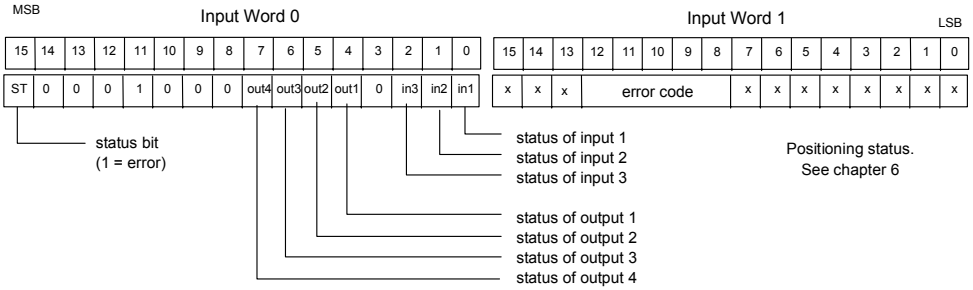
Controlling Independent Digital Outputs

For this type of application, the host can control the outputs using output word 0, bits 7 to 4 of a C*ontrol Positioning* command. Even though the outputs are not being used for positioning, their states can still be set using these bits.


MSB
Output Word 0
Output Word 1
LSB
15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0
15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0
1 0 0 0 x x 0 0 out4 out3 out2 out1 0 jogn jogp 0
drmf alfc elp elp dbc abc 0 0 0 0 epr2 spr2 epr1 spr1 aerr stop
Control Positioning Command
Commanded states of outputs 1 - 4

Reading Positioning Data, Independent Inputs, and Status

During operation, the module returns positioning information in word 1 of its input data, as detailed in chapter 6. The current states of the inputs and outputs are returned in input word 0/ This input data is stored in the NIU, where it can be read by the application host using a *Read Status* command.


MSB
Input Word 0
Input Word 1
LSB
15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0
15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0
ST 0 0 0 1 0 0 0 out4 out3 out2 out1 0 in3 in2 in1
x x x error code x x x x x x x x
status bit (1 = error)
status of input 1
status of input 2
status of input 3
status of output 1
status of output 2
status of output 3
status of output 4
Positioning status. See chapter 6

If a positioning error has occurred, the status bit is set to 1. The type of error that occurred is indicated by the error code.

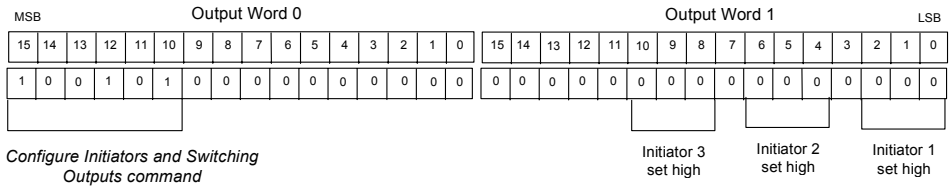
Positioning Command Example: Incremental Encoder Module: Homing

Incremental encoders cannot return the absolute position after power up, so a position must be defined using the homing process.

In this example, during homing, the zero point signal (Z signal) of the incremental encoder is used to synchronize the actual value with a fixed reference point in the positioning range.

Setting Up the Initiators

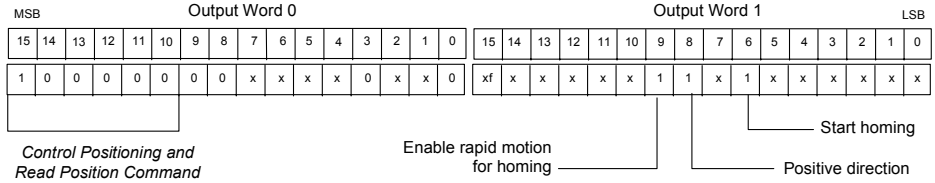
In this example, during parameterization with the *Configure Initiators and Switching Outputs* command, the initiators (inputs) have been defined as active high:


MSB
Output Word 0
Output Word 1
LSB
15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0
1 0 0 1 0 1 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
Configure Initiators and Switching Outputs command
Initiator 3 set high
Initiator 2 set high
Initiator 1 set high

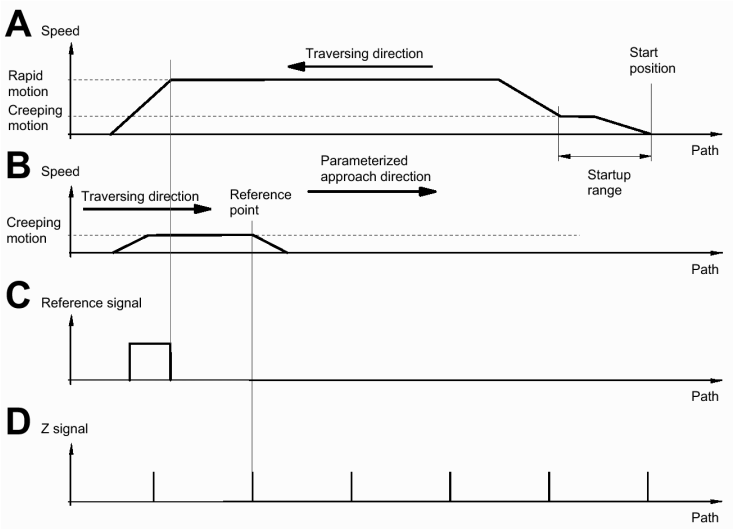
Starting the Homing Process

In the same example, the system host starts and controls the homing process using a *Control Positioning and Read Position* command.

During operation, a positive edge on word 1, bit 6 of this command starts the homing process. Bit 8 is 0, so the reference point is approached in a positive direction. To approach the reference point in a positive direction, the drive first travels in a negative direction when homing is started. In addition, bit 9 is set to 1 to enable rapid motion for the homing process.


MSB
Output Word 0
Output Word 1
LSB
15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0
1 0 0 0 0 0 0 0 x x x x 0 x x 0
xf x x x x x 1 1 x 1 x x x x x x
Control Positioning and Read Position Command
Enable rapid motion for homing
Start homing
Positive direction

At the beginning of the approach (A below), the drive accelerates up to rapid speed. The drive travels at rapid speed in a negative direction until the module detects a negative edge at the reference mark input (C).



As soon as the drive has stopped (B), the direction changes and the drive travels at creeping speed. After the negative edge at the reference mark input, on the first positive edge of the zero point signal (Z signal; D above) of the incremental encoder, the value of the reference point is accepted as the current value. The module resets all outputs and sets bit 6 in the status word (homing completed successfully).

The module also offers the option of homing without consideration of the Z signal In that case, the falling edge of the reference point signal is accepted as the reference point.

For a rotary axis, movement is in the specified approach direction, and is always at creeping speed.

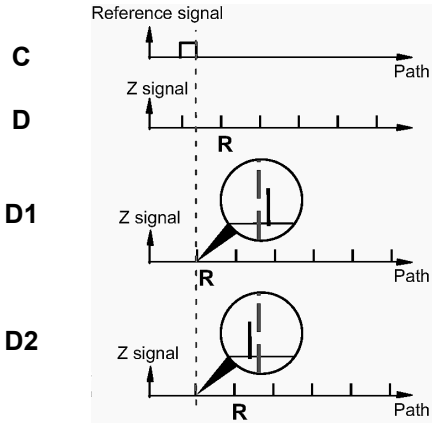
It is possible that the starting point for homing is between the reference point and limit position, and the traversing direction is parameterized so that the limit position is reached first. The drive reaches the limit switch before it receives a signal from the reference mark input. It then changes traversing direction, and travels in the opposite direction at creeping speed. After the negative edge at the reference mark input, on the first positive edge of the zero point signal (Z signal) of the incremental encoder, the value of the reference point is accepted as the current value. The module resets all

outputs, and sets *Read Status* input word 1, bit 6 (Reference point set successfully).

Position of the Z Signal

When starting the system, the position of the falling edge of the reference signal should be between two Z pulses. This minimizes the risk of reference point shifting.

In the following illustration, the reference point is clearly identified. The falling edge of the reference signal is somewhere between two Z pulses. If the Z signal is shifted due to wear or pollution, this Z signal is always detected for determining the reference point. This is not guaranteed in D1 and D2 below. The falling edge of the reference signal falls on a pulse of the Z signal. The signal can be shifted by wear or pollution. If it is just **after** the falling edge of the reference signal, this Z signal is detected to determine the reference point. If it is just **before** the falling edge of the reference signal, only the next Z signal is detected to determine the reference point.



If a response like this is suspected or can be detected using an oscilloscope, the encoder must be removed from the shaft, turned a half rotation, and fixed again tightly.

Make sure only one initiator is activated as the source of the reference signal (see *Define Initiators and Switching Outputs* command in chapter 4).

Homing to a Limit Switch

It is also possible to synchronize with a limit switch. The reference mark source is configured using the *Define Initiators and Switching Outputs* command as described in chapter 4.

If you have defined a limit switch as a reference mark, be sure to select the correct approach direction for homing. This will depend on the whether initiator 1 or initiator 2 is being used. For initiator 1, "Minimum Limit and Home Switch Position" (see chapter 4 for more information), positive homing must be selected. For initiator 2, "Maximum Limit Switch and Home Switch Position", negative homing must be selected.

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